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CONTENTS:

Charles Alfred Weatherby, Botanist and Helper of Botanists (with Portrait). *M. L. Fernald.* 169

Bibliography of Charles Alfred Weatherby. *M. L. Fernald and Bernice G. Schubert.* 179

Note on Chrysosplenium iowense. *Hiroshi Hara.* 191

Errors of Citation in Agrostis and Convolvulus. *M. L. Fernald.* 192

Contributions from the Gray Herbarium of Harvard University—No. CLXX. The American Barbistyled Species of Tephrosia (Leguminosae). *Carroll E. Wood, Jr.* 193

The White Form of Aster puniceus, var. firmus. *Haskell Venard.* 231

Basicladia in Maine. *R. M. Chute.* 232

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Sincerely yours,

C. A. Weatherby

Rhodora

JOURNAL OF

THE NEW ENGLAND BOTANICAL CLUB

Vol. 51. September, 1949 No. 609

CHARLES ALFRED WEATHERBY, BOTANIST AND HELPER OF BOTANISTS

M. L. Fernald

(With portrait)[1]

Systematic botanists, and especially workers on the *Pteridophyta*, were saddened and almost shocked by the sudden death of Alfred Weatherby from a blood-clot early in the morning of June 21 last. Weatherby had so long been leaned upon for careful decisions regarding the classification of ferns, intricate questions in nomenclature and bibliography and matters of style in botanical writing that it seemed inconceivable that his always patient helpfulness to everyone must so soon cease. His place can hardly be filled.

Charles Alfred Weatherby, intimately known as Alfred, was born on Christmas day, 1875, the son of Charles Nathaniel and Grace Weld (Young) Weatherby, at Hartford, Connecticut. In his own words[2], "Except for three years in Colorado Springs (which I remember as a place where one fell into irrigating ditches and had nose-bleed), I was brought up in East Hartford, then a country village with a hundred-foot wide street shaded by old elms, without electric lights, gas, telephones, sewers, city water, plumbing, or pasteurized milk, where one wore a bag of camphor

[1] The photograph was taken in the Herbarium of the Royal Botanic Gardens at Kew, in July, 1939, by the eminent pteridologist, Mr. Francis Ballard. The engraving is contributed, as his expression of admiration, by Mr. Thomas F. Burbank of the Wright Company, Engravers.

[2] The quotations regarding his own life are taken directly from Weatherby's brief and always modest autobiographical memoranda in the several printed Reports of the Class of 1897 of Harvard College.

hung about one's neck to fend off contagious disease, and where everybody was definitely more contented than now when they have all the above-mentioned blessings, no trees, a hundred feet of concrete pavement and rows of filling stations". In other words, he had the simple and unsophisticated boyhood of most boys of his generation who grew up in villages or small towns but who often had sulphur substituted for camphor in the bag suspended on a string from the neck.

The Hartford high school being then unable to fit boys for Harvard, Alfred was sent to local private schools and finally entered Harvard with the class of 1897, he stating, fifty-four years later: "I rather think I was the second boy to go to Harvard from Hartford since colonial times, speeded thither by the prediction of an old family friend that I should return a Unitarian and a free-trader. What I did learn was never to despise authority in intellectual matters and never to accept it unquestioned"; the latter most valuable intellectual attitude perpetually brought to bear in his future scientific writings. In college Weatherby concentrated in literature and allied fields, led a somewhat retiring life, with his special friends those of scholarly interests, joined none of the generally recognized college "clubs" (except the local chapter of *Delta Upsilon*, and a little exclusive group of eight congenial souls known, at least to themselves, as the Epicureans and who, Mrs. Weatherby informs me, kept up regular stimulating and amusing communications) nor any athletic teams. He was, therefore, of the quiet, undemonstrative and non-athletic type (as was, also, the present writer) whom some recent spokesmen would exclude from college as poor investments. He graduated with highest honors (*summa cum laude*), a fact which he modestly omitted from his published autobiographical notes, and as a member of *Phi Beta Kappa*. A year in the Harvard Graduate School gave him his A.M. in modern languages.

Five years of the closest study, without much physical activity, proved too much for his naturally limited strength, for in 1903 he wrote: "since I left Harvard in 1898, my health has been so poor that I have been unable to do any regular work". In a later summary he said: "I was an invalid for five years, twice given up by my physician, and was never really rugged there-

after. From this experience I learned that literature, my chief study in college, was for me a poor support *in extremis* and that science (I had botanized as a hobby) offered a much firmer foothold". More concrete as to his entry into a scientific field was his statement in 1912: "For a long period it was desirable for me to be as much as possible out of doors. Thereby an interest which I always had in the life of woods and fields, especially in plants, was stimulated until it became paramount". Thus the fields of botanical taxonomy, bibliography and the technical study of nomenclature became the gainers. Five years of intensive concentration in the literary field, followed by five years of invalidism, saw his start in a new and absorbing interest, and leaders in the classification of vascular plants the world over have applauded the scholarly advances in these subjects made by a seriously handicapped worker who never took a formal course in botany. He had, however, at his fitting school, the Collins Street Classical School in Hartford, and in his five years of devotion to literature at Harvard[1] acquired a linguistic background which was indispensable in the specialized field in which he became one of the most respected authorities—a field in which the great basic works were written in Latin and in which all new entities must, by International agreement, be described in Latin (instead of English, Polish, Chinese, Russian or other languages) in order to have validity. If he had been under the influence of those pragmatic scientists who today decry a classical background as a "waste of time" he would have been in the unfortunate position of those of us who, keenly interested in taxonomy and its related disciplines, have had to learn the hard way, by finding good models of the old school and trying to imitate their Latin. Or, if he had had only the minimum of training in rhetoric, syntax, philology and accurate composition nowadays allotted to students in the scientific fields, he could not have entered a polemical subject such as brewed for some time in Science in 1944. Toward the end of that particular discussion Weatherby published in Science for May 5, 1944, the following characteristic note:

[1] At a time when the elderly Francis J. Child and A. S. Hill headed a group of such younger masters in English and allied fields as Briggs, Barrett Wendell, Kittredge, F. N. Robinson and others.

"HORSE SERUM" A COMPOUND WORD

The discussion of "horse serum" has already reached considerable length, but it may be permissible to make one more point—namely, that every one concerned has misinterpreted the nature of the disputed phrase. It is not a case of one noun being used as an adjective to modify another; it is a compound noun, exactly analogous to such Greek compounds as thermometer. The first member takes the place, not of an adjective, but of a phrase. "Horse serum" is serum from a horse; "fence post" is post of a fence; "rat poison" is poison for rats. Thermometer, if its first member were adjectival, would mean a "hot meter," not a measure of heat. In most such cases, the compound has a special and definite meaning, not conveyed by an adjective and noun. Had this been understood, neither the original editorial faux pas nor the resultant burst of argument need have occurred. The author (or, if he forgot it, the editor) would merely have inserted a hyphen between "horse" and "serum" and all would have been well.

That the situation was not understood is partly because, though the use of compounds in place of prepositional or other phrases in English has increased in recent years by leaps and bounds, we have not yet developed a consistent or in any way adequate orthography for indicating them. This is admirably illustrated by the playful contributor who wrote "horse sense" and "horse-laugh" in the same sentence. The makers of the Century Dictionary perceived the usefulness of the hyphen as an indicator, but few have followed them. So long as we offend the verities by writing compounds as separate words—which they are not—we shall have confusion and wrangles like the present.

C. A. WEATHERBY

GRAY HERBARIUM,
HARVARD UNIVERSITY.

In the same vein but we hope not prophetic was his article on *Compound Words in present-day English*, published in Science for May 5, 1939. A single paragraph suffices to show a master's hand:

Thirty years ago every one, probably, would have written "Department of Biology". Now half the colleges in the United States have "Biology Department", or the like, on their stationery. Certainly, thirty years ago no one would have put forth such a title as "Cost Analysis of Scholarly Periodical Printing". Then it would have read: "An Analysis of the Cost of Printing Scholarly Periodicals". In time, as we become more definitely conscious of what we are doing, it may read: "Costanalysis of Scholarly-periodicalprinting".

After seriously entering botany as an amateur, Weatherby soon found himself drafted by the Connecticut Botanical Society as a member of the Committee to prepare a flora of the state, the *Catalogue of the Flowering Plants and Ferns of Connecticut*, published in 1910. The other members of the Committee were amateurs with remarkably full field-knowledge of their areas but

to Weatherby fell the task of coördination, the checking of recent revisions and the translation of specific and varietal names. These responsibilities brought him to the Gray Herbarium, where his unusual capacity for painstaking work was promptly recognized. He spent much of his time in the summers of 1908, 1909 and 1911 as a voluntary Assistant at the Herbarium, his first articles in the series, Contributions from the Gray Herbarium of Harvard University, being published in 1910 (although, beginning in 1904, he had been publishing minor notes in RHODORA) and dealing with a genus of the *Liliaceae*, the variations of *Lycopodium complanatum* and studies of various flowering plants of Mexico. His concentration on the *Pteridophyta* had not then begun.

From this time on Weatherby continued as a part-time and largely voluntary Assistant at the Gray Herbarium, cheerfully taking on tasks needing attention or carrying on individual studies but continuing to live at East Hartford with his mother. His marriage in Boston on May 16, 1917, to Una Lenora Foster brought a great change in his life. He now had a sympathetic partner on his botanical journeys and in his studies and a skillful artist to record many details of plants upon which he was working; and when in 1929 they moved to Cambridge their home quickly became the social center for all regular workers and all visitors at the Gray Herbarium. In fact, many visiting botanists were immediately taken into the Weatherby home for their visits to Cambridge and when they were to be away on long trips, either in America or in Europe, some botanist who needed to spend the summer in Cambridge was regularly invited to occupy their house. On moving to Cambridge Weatherby became full-time Assistant in the Gray Herbarium, becoming Assistant Curator in 1931, Senior Curator in 1937; and on retiring in 1940 he was appointed Research Associate. In the latter wholly honorary capacity he worked assiduously on the ferns and on problems in nomenclature and bibliography until late in the afternoon before his death.

Throughout this long service Weatherby, like all who are really devoted to their work, watched the clock only in order to keep appointments, overlooking most holidays and almost regularly appearing at the Herbarium, to continue his studies uninter-

rupted, toward noon on all Sundays when he was in Cambridge. He was interested in all vascular plants and after he and the writer had made a close study of *Puccinellia* he had a strong leaning toward the *Gramineae* as absorbingly interesting; but, gradually becoming conscious of the vast amount of intensive study needed by the *Pteridophyta*, especially of tropical and austral America, he got more and more into those problems and would gladly have spent all his time, after his curatorial responsibilities, upon them. Unfortunately for those groups of plants, however, his deeply entrenched "New England conscience" and his always kindly temperament perpetually got in the way. He would not turn away from inquiring visitors. No question about anything within or bordering on his fields would be dismissed by him. Consequently, amateurs and professionals of all grades perpetually came to him for help and advice. Time-consuming visitors would allow themselves to occupy his time on rather trifling matters; and too often those who should, through long experience, have learned the location in the library of standard works, would calmly sit while he got the books for them! This unfailing devotion to all who asked his aid was considered by him a real duty. Some others, hearing the voice of an approaching interrupter, would quietly gather up their work and fade from sight. Not so Weatherby. He would not have approved of Thomas Nuttall's trap-door.[1]

Nevertheless, in spite of this most conscientious aiding of others, he accomplished large results and his remarkably extended bibliography (which would total many more titles if he had not so often refrained from appending his initials to memoranda and discussions which obviously came from his pen) shows a good share of outstanding technical studies, interspersed with minor notes and wonderfully illuminating reviews. Many scores of letters received from botanists all over the world by Mrs. Weatherby emphasize his remarkable capacity to accomplish large results in scientific writing, while giving liberally of himself

[1] In the fine old house in the former Harvard Botanic Garden where Nuttall had lived Mrs. Asa Gray "had retained Nuttall's trap-door. In the corner of the large living-room and study there hung a stout cord. Whenever Thomas Nuttall heard the garden-gate click or a step on the walk he pulled the rope and the trap-door in the ceiling opened nearly to the floor, with a step-ladder on its upper side. Then Nuttall disappeared and was never at home".—Fernald in Proc. Am. Phil. Soc. lxxxvi. 66 (1942).

to all who needed help. All such letters are in the same affectionate and appreciative vein and they are beautifully exemplified by a brief note to the present writer from one whose too rare visits to the Gray Herbarium have been a joy looked forward to by all the staff, the skillful and remarkably informed historian of southwestern science, Professor Samuel W. Geiser:

> I have noticed, with real sorrow, your terminal note in the July Rhodora on the death of Mr. Weatherby. He was to me on numerous occasions most kind, most helpful, most considerate; and both Dr. Shinners and I shall constantly remember him as one of the ornaments of the Gray Herbarium. Like everyone else who knew him, whether well or less intimately, we shall miss him very much. Do not think me presumptuous if I give my condolences to the Herbarium Staff members whom I am acquainted with.

Another responsibility assumed by him was his liberal aid in the preparation of the Gray Herbarium Card Index. Carried forward primarily by Miss Marjorie W. Stone, the Index constantly brought up technical problems: deciding what category was intended by authors who neglected to clarify such questions; finding the exact date of issue of obviously misdated publications; determining whether authors actually accepted combinations and names which they carelessly published; and many intricate and unforeseen dilemmas requiring technical understanding. So far did Weatherby's careful consideration of such details enter into the Index that many subscribers considered the solutions as indicating that he was the maker of the whole series of cards and that his decisions could not be challenged. His keenness in such matters led to his election to the British Society for the Bibliography of Natural History.

As an adjunct to his studies in Cambridge Weatherby's several visits to the European herbaria were important. On these trips he was regularly accompanied by Mrs. Weatherby. While he made critical examination of types in the groups on which he was working she supplemented his notes by photographs or drawings. Similarly, they made photographs and notes on the types of Stephen Elliott so far as they are preserved at the Charleston Museum.

Quite outside the special work of or associated with the Gray Herbarium his constant activity and resourcefulness were apparent. One of the original members of the Connecticut Botanical

Society and its Vice-President for nearly twenty years, he rarely, if ever, missed one of its annual meetings. His work on the great Catalogue has already been noted. An early member of the American Fern Society, which he joined in 1912, he began publishing in its Journal in 1913 and from then until his death most numbers contained his illuminating articles, technical notes, reviews and editorial items. He was inclined to take no credit for the brief notes and reviews, sometimes signing them, often not; but, even so, his finished style, references to earlier signed reviews or other clues often identify the author, for even in severe criticism of work which was superficial, hasty or ill-advised his whimsical humor would appear. Thus, in his detailed analysis of Dickason's *Phylogenetic Study of the Ferns of Burma* and that author's unsuccessful attempts to account for many lines of descent (or ascent), the reviewer tucked in the footnote: "Taken by and large, the critics of Darwin seem to have worked themselves into the position of maintaining that he was wrong in just about everything except his main conclusion. It might not be amiss to remember, now and then, that one of the salient features of Darwinian theory is its innate reasonableness". Am. Fern Journ. xxxvii. 28 (1947). Continuing the discussion, Weatherby wrote on the next page: "Incidentally, in making up his series, Dickason has accepted 32 out of 33 of Ching's families segregated from Polypodiaceae. But, though he reproaches Ching for inadequate discussion, he can find no better reason for this acceptance than Ching's own—'that it is in harmony with the present tendency'. One can say as much for women's hats." Then follows: "After such discussion, one feels a sort of yearning for the simplicity and neatness of soral development in Diels's treatment of the Polypodiaceae." Then, after discussion of theories of soral development and change, he concluded his brilliant and really important discussion: "Any phylogenist will tell you this is too good to be true; and probably he is right; nature is not so simple. But not every day does one find a fairy-tale which fits so nicely with observed facts."

This insistence on recognition of the soundness (until proved unsound) of the work of Diels and other cautious and closely reasoning students of the ferns and the unsoundness of the work of Ching and his followers was again made apparent in a late

review published by Weatherby in the Fern Journal (xxxix. 59–61). There discussing the rather hasty and often inaccurate *Phylogeny and Ontogeny of the Pteropsida. I. Schizaeales* by Dr. Clyde F. Reed, Weatherby opened with a footnote: "One might take exception to certain slips in Latin, which, though pardonable in these days of non-classical education, could have been reduced in number by a little more attention to a grammar, a lexicon, and to the good models provided by Prantl." Then, after some analysis of the work he concludes:

> Dr. Reed seems to have taken Ching as a model. Like Ching, he fails to give any direct or adequate answer to the query which at once arises: why and how does phylogeny require the erection of genera into families and the more or less jacking up in rank of previously recognized groups? This is an unfortunate lack, for it generates in skeptical minds the suspicion that phylogeny is, in these cases, only camouflage for plain, old-fashioned splitting. Whether or not this suspicion is justifiable, there is no doubt that, in such work as the present, taxonomy (properly, the construction of cross-sections of lines of descent) and phylogeny (properly, the conjectural following back of these lines into the geologic past) tend to become synonymous. In spite of their interlocking nature they are not the same thing. When this is recognized and really interpretative discussion provided, work like Dr. Reed's, which undoubtedly represents a strong present trend in classification, will become more convincing.

Such reviews, like those of Small's *Manual* and others in which conservatism is thrown to the wind, should not remain partly hidden in the specialized journals in which they appeared. Their reading and careful consideration by students in those biological fields where it is the ignorant custom to "knock" taxonomy as "mere collecting of postage stamps" would, if that is possible, bring a ray of illumination to their too often cloistered outlooks.

Returning more directly to the American Fern Society, it should be noted that in 1915 Weatherby joined the board of Editors of the American Fern Journal, continuing as an Editor to 1940, and in 1943 and 1944 he was President of the Society. His services to the Society were unlimited and when he resigned in 1940 as an Editor his coworker through many years, Dr. Ralph C. Benedict, closing a highly appreciative account of Weatherby's work for the Society, wrote (Am. Fern Journ. xxxi. 3):

> New Englanders are notably reticent, not given to volubility in the expression of personal views and philosophy. However, it is possible at times to discover a man's aims and point of view indirectly, by noting how

he appraises others and what he admires in them. Read Mr. Weatherby's tribute to C. H. Bissell, in Volume 15 of the Journal. From that I quote, with a minor modification, a sentence which most appropriately characterizes Charles Alfred Weatherby today: "A man to whom his fellow members turn with entire confidence in any matter which calls for perfect integrity, sound judgement, and constructive ability."

Similarly, the New England Botanical Club owes much to him. A member since 1906, he was Librarian from 1928 and in 1929 he became one of the Associate Editors of Rhodora. With his critical aid essentially all (except those of the late Alexander W. Evans and a few others who wrote unexcelled English) manuscripts and proof-sheets of Rhodora were scrupulously read, up to some papers still unpublished; and many authors accepted without demur the introduction of hyphens or semicolons and corrections of English and Latin, matters in which, without his watchful eye, future numbers of the journal may become delinquent. In 1945 he served as President of the American Society of Plant Taxonomists and from 1943 was an Editor of Brittonia. Much of his time was taken up in the preparation of the unofficial special edition of the International Rules of Botanical Nomenclature (with Camp and Rickett) published in Brittonia in 1947. Much more went into the canvass of American botanists and the preparation (as a member of the Central Committee on Nomenclature of the American Society of Plant Taxonomists) of the Proposed Changes in the International Rules of Botanical Nomenclature, published in Brittonia for June, 1949.

He had taken his turn as a Councillor of the American Academy of Arts and Sciences, as an Editor of the American Journal of Botany, as Chairman of the Committee on Nomenclature of the Botanical Society of America; and doubtless in many other helpful capacities which his modesty prevented his noting in his statements in the usually available sources of such information. The recognition of his keen understanding of problems in nomenclature which most pleased him and which loaded him with a full quota of laborious study, was his appointment at the International Botanical Congress at Amsterdam in 1935 as one of the two[1] American members of the International Committee on Nomenclature of Vascular Plants, an appointment which he, like his coworker, Rehder, took as meaning real study. His last

[1] Alfred Rehder, the second member, died one month after Weatherby, on July 21, 1949.

hours at the Gray Herbarium were spent on work of this Committee. Only a few days earlier he had been greatly pleased by his appointment as Vice-President of the Section on Nomenclature of the International Botanical Congress to be held in Stockholm in the summer of 1950, and he and Mrs. Weatherby were arranging for their passage to Stockholm. Most unfortunately, the Section on Nomenclature will be without his cautious and wise counsel.

As if all these activities were not enough to satisfy the intellectual appetite of anyone, Weatherby kept up a keen interest in and appreciation of music and art and, for good measure, spent many evenings with his volumes on military history and strategy. Mrs. Weatherby tells of his reading the details of manoeuvers in Europe during the second world-war and suddenly exclaiming: "There, you see, they have done what I said they should do"—this from one of the most peaceful and peaceable men who ever lived.

Those who have best known him have long recognized the rare qualities of Alfred Weatherby: his patience and unselfish devotion to what he conceived as his duty; his loyalty to friends, even though he strongly differed with them; his capacity for close and accurate study under handicaps which would discourage others; his cheerfulness in the face of obstacles and his readiness to set aside his own interests in order to help those who asked his assistance. These are superlative virtues and not often met. It is doubtful if in these days such a botanist and helper of botanists can be found to take his place.

Gray Herbarium.

BIBLIOGRAPHY OF CHARLES ALFRED WEATHERBY

Compiled by M. L. Fernald and Bernice G. Schubert

[Omitting official Notices and unsigned Memoranda; also unsigned Reviews in the American Fern Journal, many of them with important criticisms and expressions of personal judgment. Also omitting two studies in literary fields, published in his senior year in college in the Harvard Monthly, xxiv. 173–184 and 207–209 (1897) and a third in vol. xxviii. 64–74 (1899).]

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40. [Notes and News, without specific title.] Reviews of or comments on publications by Van Eseltine, Small, Maxon, Berry, E. W. Brown and W. N. Steil. Ibid. ix. 23–27.
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42. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1918. Ibid. 30, 31.
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44. Further Notes on Impatiens biflora. Ibid. 98–100, figs.
45. An Omission in the preliminary List of New England Ranunculaceae. Ibid. 104.
46. Changes in the Nomenclature of the Gray's Manual Ferns. Ibid. 173–179.

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48. Records of monomorphic Equisetum Telmateia. Ibid. 122, 123.

49. Habenaria psycodes, var. ecalcarata in Vermont. Rhodora, xxii. 31, 32.
50. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1919. Am. Fern Journ. x. 31, 32.
51. [With C. H. Knowlton and W. S. Ripley, Jr.] Second Report of the Committee on Floral Areas. Rhodora, xxii. 80–89.
52. More interesting fern localities. Am. Fern Journ. x. 57–59 [unsigned].
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54. [Review—under Recent Fern Literature.] Work by Graff. Am. Fern Journ. x. 89.
55. A European Primrose in New England. Rhodora, xxii. 143.

1921

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57. [Review—under Recent Fern Literature.] Works by Holm and by Small. Ibid. 121–123.
58. [With M. L. Fernald.] Equisetum fluviatile or E. limosum? Rhodora, xxiii. 43–47.
59. A Form of Ilex opaca. Ibid. 118, 119.
60. Old-time Connecticut Botanists and their Herbaria,—II. Ibid. 121–125, 171–177.
61. Other Records of Salvinia natans in the United States. Am. Fern Journ. xi. 50–53.
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1922

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64. The Climbing Fern in the Vicinity of Hartford. Am. Fern Journ. xi. 109–113, plate 2.
65. A Correction [with publication of Polypodium vulgare, f. brachypteron Ridlon]. Ibid. 122.
66. Barratt, Torrey and Schweinitz: a Correction. Rhodora, xxiii. 300, 301.
67. A New Species of Eleocharis from Massachusetts. Ibid. xxiv. 23–26.
68. Some Amateur Observations on Color-forms. Torreya, xxii. 37–42.
69. [With M. L. Fernald.] Varieties of Geum canadense. Rhodora, xxiv. 47–50.
70. Is Botrychium dissectum a Sterile Mutant? Am. Fern Journ. xii. 9–12.
71. On a Supposed Hybrid in Equisetum. Ibid. 12–16.
72. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1921. Ibid. 28, 29.
73. [With E. B. Harger and others.] Additions to the Flora of Connecticut. Series 2. Rhodora, xxiv. 111–121.
74. The Group of *Polypodium lanceolatum* in North America. Contrib. Gray Herb. n. s. lxv., pt. i. 3–14.

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77. The Identity of Carex gynandra Schwein. Rhodora, xxv. 115, 116.
78. A Mysterious Reprint of no. 1 of the Fern Bulletin. Am. Fern Journ. xiii. 97, 98.

1924

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80. [Review—under Recent Fern Literature.] Marie-Victorin's *Les filicinées du Quebec*. Ibid. 118–120.
81. Two more Wool-waste Plants from Westford, Mass. Rhodora, xxvi. 38, 39.
82. Another Davenport Fern Herbarium. Ibid. 49–55.
83. [Review.] Standardized Plant Names. Am. Fern Journ. xiv. 19, 20.
84. Osmunda Claytoniana, forma dubia. Ibid. 21.
85. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1923. Ibid. 30, 31.
86. A New Satureja from Florida. Rhodora, xxvi. 80, 81.
87. Note on the Forms of Polypodium virginianum. Am. Fern Journ. xiv. 60, 61.
88. A Note on Stellaria pubera Michx. Rhodora, xxvi. 169–171.
89. The Herbarium of George E. Davenport. Am. Fern Journ. xiv. 94, 95.
90. The Earliest Record of Proliferous Ebony Spleenwort. Ibid. 95, 96.

1925

91. Note [without title] on occurrence of Rusts on Ferns. Ibid. 123, 124.
92. Gaura parviflora Dougl., var. lachnocarpa. Rhodora, xxvii. 14, 15.
93. [With C. H. Knowlton and W. S. Ripley.] Fourth Report of the Committee on Floral Areas. Ibid. 56–65.
94. [Discussion—under Recent Fern Literature.] Papers by Stokey and Starr and by Degener on Prothallia of Lycopodium. Am. Fern Journ. xv. 19–21.
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96. Inconstancy in Color-forms of Hepatica americana. Rhodora, xxvii. 131, 132.

1926

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98. Lygodium palmatum in Berkshire County, Mass. Ibid. xvi. 26, 27.
99. A new Magnolia from West Florida. Rhodora, xxviii. 35, 36.
100. [With C. H. Knowlton and R. C. Bean.] Fifth Report of the Committee on Floral Areas. Ibid. 43–46.
101. Note [without title, except on cover] on Forked and Crested Forms of Ferns. Am. Fern Journ. xvi. 60.
102. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1925. Ibid. 68, 69.
103. A new North American Variety of Cystopteris fragilis. Rhodora, xxviii. 129–131.
104. On Solidago rigida L., and the Application of old Botanical Names. Ibid. 138–145.

1927

105. Equisetum pratense in Berkshire County, Mass. Ibid. xxix. 32.
106. Imperfectly circinate Vernation in Ferns. Am. Fern Journ. xvi. 109–111, figs.
107. [A detailed Review—under Recent Fern Literature.] Chrysler's study of Abnormalities in Botrychium and certain other Ferns. Ibid. 120–123.
108. Comment [without title] on Abnormal Forms of *Botrychium*. Ibid. 127, 128.
109. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1926. Ibid. xvii. 71, 72.
110. A New Polypodium from Mexico. Ibid. 91–94, plate 5.
111. The Group of Acalypha virginica in Eastern North America. Rhodora, xxix. 193–204.
112. Tetramerism in Trillium undulatum. Ibid. 223.
113. A Teratological Form of Vaccinium pennsylvanicum. Ibid. 237, 238.
114. [Review.] Blewitt's Flora of Waterbury, Connecticut. Ibid. 240.

1928

115. [With C. H. Knowlton and R. C. Bean.] Sixth Report of the Committee on Floral Areas. Ibid. 247–253.
116. [Notice.] "Additions to the Flora of Worcester County, Massachusetts". Ibid. xxx. 20.
117. Imperfectly Circinate Vernation in Ferns. Am. Fern Journ. xviii. 31, 32.
118. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1927. Ibid. 34, 35.
119. William Stout, a Forgotten Student of Ferns. Ibid. xviii. 37–45 (portrait).
120. A new Species of Juncus from Colombia. Contrib. Gray Herb. lxxxi. 84.
121. A Note on the Genus Paspalum in New England. Rhodora, xxx. 133–135.
122. A Variety of Hypericum canadense. Ibid. 188–190, 2 figs.
123. Discussion [without title] of a series of Questions. Am. Fern Journ. xviii. 129, 130.

1929

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125. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1928. Am. Fern Journ. xix. 68–70.
126. [With M. L. Fernald.] Proposed Amendments to the International Rules of Botanical Nomenclature. Rhodora, xxxi. 91–96.
127. [With C. H. Knowlton and R. C. Bean.] Seventh Report of the Committee on Floral Areas. Ibid. 106–118.
128. Two Variants of Ranunculus recurvatus. Ibid. 163, 164.
129. Seed versus Sorus. Am. Fern Journ. xix. 102–104.

1930

130. [Discussion—under Recent Fern Literature.] Work by Copeland, Christensen, Fernald, Weatherby, W. A. Anderson and Friesner. Ibid. xx. 25–30.

131. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1929. Ibid. 34–36.
132. [Review.] Deam's Grasses of Indiana. Rhodora, xxxii. 117, 118.
133. Distinguishing Woodsia and Cystopteris. Am. Fern Journ. xx. 85, 86.
134. [Review or Comments—under Recent Fern Literature.] On work of Bush, Clute and Mrs. Josephine F. Clark. Ibid. 120–123.

1931

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137. [With R. C. Benedict and E. J. Winslow.] Report of the Editors [of Am. Fern Journ.] for 1930. Ibid. 78, 79.
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139. The Group of Asplenium fragile in South America. Ibid. pt. v, 49–52.
140. [With M. L. Fernald.] Some new Plants from the Gaspé Peninsula. Rhodora, xxxiii. 231–240, 1 fig.
141. [Review.] Hitchcock's "Field Work for the Local Botanist". Ibid. 244, 245.

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144. A Curious Phenomenon in the Christmas Fern. Am. Fern Journ. xxii. 55, 56, fig.
145. Note [without title]. On Florist's Use of *Polystichum munitum*. Ibid. 60.
146. Anacharis densa on Long Island. Rhodora, xxxiv. 151, 152.
147. [With M. L. Fernald.] Bartonia; a Comedy of Errors. Ibid. 164–167.
148. [With M. L. Fernald.] Pinus Strobus L., forma prostrata (Mast.) comb. nov. Ibid. 168.
149. [With M. L. Fernald.] Picea glauca, forma parva. Ibid. 187–189.
150. [With M. L. Fernald.] Abies balsamea (L.) Mill., forma hudsonia (Bosc) comb. nov. Ibid. 190, 191.
151. [With M. L. Fernald.] Picea rubens Sarg., forma virgata (Rehder), comb. nov. Ibid. 211.
152. [Discussion—under Recent Fern Literature.] Studies by Marie-Victorin in *Lycopodium* and *Botrychium*. Am. Fern Journ. xxii. 95–97.
153. Note [without title]. On color of the American Royal Fern. Ibid. 101.
154. An Addition to the Wool-waste Flora of eastern Massachusetts. Rhodora, xxxiv. 214, 215.

1933

155. Panicum dichotomiflorum, var. puritanorum in New Hampshire. Ibid. xxxv. 68.
156. Walter Deane. Ibid. 69–80 (portrait).
157. Aristida longespica in Connecticut. Ibid. 386.

1934

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159. Epifagus virginiana (L.) Bart., forma pallida, n. f. Ibid. 59.
160. [Discussion—under Recent Fern Literature.] Papers on Ferns and Fern Allies of Missouri by Palmer and Steyermark and by M.E. Pinkerton. Am. Fern Journ. xxiv. 18–21.
161. Ferns in Bottles. Summary of paper by Charles E. Benham. Ibid. 27, 28.
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163. [With R. A. Ware and F. W. Hunnewell.] Report of Committee on Revision and Investigation, American Fern Society. Am. Fern Journ. xxiv. 60.
164. [With M. L. Fernald.] Some Inadequately Characterized Species of George Vasey. Rhodora, xxxvi. 346–348.

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170. Collinsia parviflora in New England. Ibid. 422.

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174. Carl Hansen Ostenfeld (1873–1931). Ibid. 565, 566.
175. Ignatz Urban (1848–1931). Ibid. 587, 588.
176. Richard Wettstein (1863–1931). Ibid. 599.
177. [Review.] Small's "Ferns of the Vicinity of New York". Rhodora, xxxviii. 163, 164.
178. A further note on Solidago rigida L. Ibid. 195, 196.
179. Nomenclature of Virginia Ferns. Claytonia, ii. 41–45.
180. [With C. H. Knowlton and R. C. Bean.] Eighth Report of the Committee on Plant Distribution. Rhodora, xxxviii. 263–271.
181. Edward Willis Graves. Am. Fern Journ. xxvi. 75, 76.

182. [Review.] Life and Work of Cyrus Guernsey Pringle. Science, n. s. lxxxiv. 137, 138 (Aug. 7).
183. On the Types of Desvaux's American Species of Ferns. Contrib. Gray Herb. cxiv, pt. iv. 13–35.
184. A new Mexican Carex. Ibid. pt. v. 36, 37.
185. [Notice.] Wiley's "Ferns of Northeastern United States". Rhodora, xxxviii. 345.
186. [Notice.] A Memorial Volume to Cyrus Guernsey Pringle. Ibid. 455.

1937

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190. Note on Tryon's Ferns of the Dune Region of Indiana. Ibid. 64, 65.
191. Note on Massey's *Shield Ferns of Virginia*. Ibid. 65.
192. The Effect of Light on the Fruiting of the Christmas Fern. Ibid. 66, 67.
193. The Identity of Meniscium oligophyllum. Ibid. 68.
194. A Further Note on Salvinia. Ibid. 98–102.
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197. Report of informal Meeting of the American Fern Society at Indianapolis. Ibid. 38, 39.
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199. [Notes—under Recent Fern Literature.] On Kalliola's study of *Dryopteris fragrans* and on Clute's *Our Ferns, their Haunts, Habits and Folklore*. Am. Fern Journ. xxviii. 66–69.
200. [Review—under Recent Fern Literature.] Clausen's *Monograph of the Ophioglossaceae*. Ibid. 116–118.
201. [Review—under Recent Fern Literature.] Verdoorn's *Manual of Pteridology*. Ibid. 118–120.
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204. On certain Type Specimens in Ferns. Contrib. Gray Herb. cxxiv, pt. v. 13–22.
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207. Certain Plant Records from Hillsboro, New Hampshire; a Correction. Rhodora, xli. 138, 139.
208. Two new Combinations in Stewartia. Ibid. 198.

209. [With W. R. Maxon.] Some Species of Notholaena, New and Old. Contrib. Gray Herb. cxxvii, pt. i. 3–17, 1 fig.

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211. Rafinesque's Types in the Group of Acalypha virginica. Rhodora, xlii. 96.
212. [Review.] Grasses and Sedges of Woodstock, Vernont. Ibid. 143, 144.
213. A Peloric Flower in Gerardia tenuifolia. Ibid. 416, 417.
214. Editorial note [without title] on the publication of a paper by Tryon. Am. Fern Journ. xxx. 104.

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216. [Review.] Deam's Flora of Indiana. Ibid. 75, 76.
217. [Review—under Recent Fern Literature.] *Ferns and Fern Allies of Wisconsin.* Am. Fern Journ. xxxi. 24, 25.
218. [Review.] Hashimoto's *Flora Nippo-Brasiliensis,* I. Ibid. 28, 29.
219. Editorial Report, 1915–1940. Ibid. 35, 36.
220. Gnaphalium obtusifolium, var. micradenium in New Hampshire and South Carolina. Rhodora, xliii. 211.
221. Lawson's Type Specimens. Am. Fern Journ. xxxi. 59–62.
222. Protective Fern Mounts. Ibid. 114.
223. [Note—under Recent Literature.] On an "unsigned" article in *Horticulture.* Ibid. 115.
224. [Note—under Recent Literature.] On recent papers by Looser. Ibid. 115, 116.
225. [Note—under Recent Literature.] On Chandler's *The common Missouri Ferns.* Ibid. 118.
226. The Argentine Species of "Notholaena". Lilloa, vi. 251–275, plates I–IV, map, figs.
227. [Review—under Recent Fern Literature.] Nessel's Die Bärlappgewächse (Lycopodiaceae). Am. Fern Journ. xxxi. 148, 149.
228. [Note—under Recent Fern Literature.] On work of Mathias González et al. Ibid. 149, 150.
229. [Review—under Recent Fern Literature.] Ching's *A new Fern Family in tropical Asia.* Ibid. 150–151.
230. [Comment—under Recent Fern Literature.] On *Weeds and Weed Seeds.* Ibid. 151.

1942

231. Proliferous Scott's Spleenwort. Ibid. xxxii. 23–25, fig.
232. [Note—under Recent Fern Literature.] On Wright and Crandall's *Rhode Island Ferns.* Ibid. 29.
233. Subspecies. Rhodora, xliv. 157–167.
234. Two Weeks in Southwestern Nova Scotia. Ibid. 229–236.
235. Fée Isotypes at Colorado College. Am. Fern Journ. xxxii. 68, 69.
236. Frederick Gillan Floyd. Ibid. 79, 80.
237. A List of Type Specimens in Elliott's Herbarium. Rhodora, xliv. 249–262 (Contrib. Gray Herb. cxli).
238. Apocynum sibiricum var. cordigerum in New England. Ibid. 331, 332.

239. [Review—under Recent Fern Literature.] Tryon's *Revision of the Genus Pteridium.* Am. Fern Journ. xxxii. 113–115.
240. [Review—under Recent Fern Literature.] Work of Hermano Daniel. Ibid. 116, 117.

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242. [Review—under Recent Fern Literature.] Ching's *The Studies of Chinese Ferns—xxxi.* Ibid. 31–33.
243. [Review—under Recent Fern Literature.] Shaver's *Some general Notes on Ferns.* Ibid. 34.
244. The Type Species of Cheilanthes. Ibid. 67–69.
245. [Notes—under Recent Fern Literature.] On studies of *Notholaena* and *Pellaea* by Looser. Ibid. 78, 79.
246. [Review.] A Check-list of Kentucky Plants. Rhodora, xlv. 278.
247. Valid and Legitimate Names—and Thalictrum polycarpum S. Wats. Madroño, vii. 83–85.
248. Polypodiaceae, Schizaeaceae, Marsiliaceae, Psilotaceae, Equisetaceae and Selaginellaceae in I. M. Johnston, Plants of Coahuila, eastern Chihuahua and adjoining Zacatecas and Durango. Journ. Arn. Arb. xxiv. 308–329.
249. An unusual Habitat for Cuscuta compacta. Rhodora, xlv. 416.
250. The Group of Selaginella Parishii. Am. Fern Journ. xxxiii. 113–119.

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251. A Southern Variety of Polypodium peltatum. Ibid. xxxiv. 17–19.
252. [Review—under Recent Fern Literature.] On edible Ferns in Fernald and Kinsey's *Edible Wild Plants of Eastern North America* and in Merrill's *Emergency Food Plants and Poisonous Plants of the Islands of the Pacific.* Ibid. 28, 29.
253. Report of the President [of the American Fern Society] for 1943. Ibid. 30–32.
254. "Horse serum" a compound Word. Science, xcix. 365 (May 5).
255. [With Marjorie W. Stone.] A Plea for the Elimination of unnecessary Nomenclatural Changes. Rhodora, xlvi. 201–204.
256. [Review.] Four studies by Looser. Am. Fern Journ. xxxiv. 63.
257. [Notes—under Recent Fern Literature.] On Rugg's transplant-experiments with Osmunda. Ibid. 97, 98.
258. The group of Selaginella oregana in North America. Journ. Arn. Arb. xxv. 407–419, plates 1 and 2.

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259. Vegetative Reproduction in Carex tribuloides and C. projecta. Rhodora, xlvii. 39, 40.
260. Alfred Barton Rendle (1865–1938). Proc. Am. Acad. lxxv. 173–174.
261. Linum catharticum in New Brunswick. Rhodora, xlvii. 68.
262. Report of the President [of the American Fern Society] for 1944. Am. Fern Journ. xxxv. 27, 28.
263. Utricularia inflata var. minor in Canada. Rhodora, xlvii. 235.
264. The Earliest Collection of Onocleopsis. Am. Fern Journ. xxxv. 52, 53.
265. Further Suggestions for the Utilization of Bracken in Great Britain. Ibid. 56.

266. [Review—under Recent Fern Literature.] Lichtenstein's *Ofioglosaceas de la Argentina.* Ibid. 58, 59.
267. [Review.] Bingham's Flora of Oakland County, Michigan. Rhodora, xlvii. 260.
268. Northwestern Limits of Cystopteris fragilis var. laurentiana. Am. Fern Journ. xxxv. 93.
269. [With John Adams.] A List of the Vascular Plants of Grand Manan, Charlotte County, New Brunswick. Contrib. Gray Herb. clviii, 96 pp., 1 plate (map).
270. [Review—under Recent Fern Literature.] Henry N. Andrews on Ancestry of *Anemia.* Am. Fern Journ. xxxv. 129.
271. [Review—under Recent Fern Literature.] Looser's *Sinopsis de los "Asplenium" (Filices) de Chile.* Ibid. 129, 130.

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272. A New Argentine Variety in Notholaena. Ibid. xxxvi. 7–9, map.
273. Changes in Botanical Names. Am. Midl. Nat. xxxv. 795, 796.
274. A New Selaginella from Western Texas. Am. Fern Journ. xxxvi. 51–53, figs.
275. [Review—under Recent Fern Literature.] Looser's *El genero Notholaena en Chile,* and his *Sobre la pteridofita Argentino-Chileana "Lycopodium confertum".* Ibid. 60–62.
276. A Variety of Athyrium decurtatum from Argentina. Ibid. 94, 95.
277. "Notholaena" in Brazil. Journ. Arn. Arb. xxvii. 361–370, plates I and II.
278. Bracken in the Bombed Areas of London. Am. Fern Journ. xxxvi. 122, 123.
279. Impatiens Roylei versus I. glandulifera. Rhodora, xlviii. 412–414.

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281. [Review—under Recent Fern Literature.] Dickason's *A Phylogenetic Study of the Ferns of Burma.* Ibid. 26–30.
282. [With W. H. Camp and H. W. Rickett.] Unofficial Special Edition of the International Rules of Botanical Nomenclature. Brittonia, vi, no. 1. 1–120.
283. Robert A. Ware. Am. Fern Journ. xxxvii. 65–67 (portrait).
284. Polypodium lepidopteris and its Relatives in Brazil. Contrib. Gray Herb. clxv. 76–82.
285. Glandular Cystopteris fragilis in the Rocky Mountains. Am. Fern Journ. xxxvii. 122, 123.
286. [Review.] Martens, *Les organes glanduleux de Polypodium virginianum.* Ibid. 124.

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288. Reclassifications of the Polypodiaceae. Am. Fern Journ. xxxviii. 7–12.
289. A Proposed New Genus and Family of Ferns. Ibid. 58–61.
290. [Note—under Recent Fern Literature.] On use of bracken for wall-linings. Ibid. 63.

291. [Review—under Recent Fern Literature.] On the study by Martens, *Formations sporangiales et "parasporangiales" chez quelques fougères.* Ibid. 93, 94.
292. [Comments—as a footnote.] On Proposed Changes in International Rules of Botanical Nomenclature. Rhodora, l. 249, 250.

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293. William R. Maxon. Am. Fern Journ. xxxviii. 98–105 (portrait).
294. Botanical Nomenclature since 1867. Am. Journ. Bot. xxxvi. 5–7.
295. Rare Scott's Spleenwort . . . One Chance in a Thousand. Horticulture, xxvii. no. 3. 85, 119, 3 photographs.
296. [Review—under Recent Fern Literature.] Study by C. F. Reed. Am. Fern Journ. xxxix. 23.
297. [Review—under Recent Fern Literature.] C. F. Reed's *The phylogeny and ontogeny of the Pteropsida. I. Schizaeales.* Ibid. 59–61.
298. [Review—under Recent Fern Literature.] Wiley's *Ferns of the Northeastern United States.* Am. Fern Journ. Ibid. 61.
299. [Review—under Recent Fern Literature.] Looser's *Los Blechnum (Filices) de Chile.* Ibid. 62.
300. [With W. H. Camp and H. W. Rickett.] Proposed Changes in the International Rules of Botanical Nomenclature. Brittonia, vii, no. 1. 1–51.

A Note on Chrysosplenium iowense.—Dr. Rosendahl's "Studies in *Chrysosplenium*, with special reference to the taxonomic status and distribution of *C. iowense*" in Rhodora **49**: 25–36 (1947) was especially interesting for me, as I have been critically studying this genus for these 15 years. After a careful study of *C. iowense* Ryberg and *C. tetrandrum* Fries, he came to the conclusion that they both are well defined species distinct from *C. alternifolium* L. and that *C. iowense* appears to be widely distributed in the Arctic.

In 1939, having examined specimens of *C. iowense*, including the type,[1] in American herbaria, I arrived independently at the same conclusion as Dr. Rosendahl that *C. iowense* is not an endemic species in Iowa, and cannot be separated from an Asiatic form of *C. alternifolium*. So in my monographic treatment[2] of Japanese *Chrysosplenium*, I referred the Asiatic entity to *C. alternifolium* var. *sibiricum* Seringe[3], citing *C. iowense* as its synonym.

[1] In moss, south side of ravine near Decorah, Iowa, *Holway*, May 5, 1889, fl. (type in N. Y. Bot. Gard.; isotype in U. S. Nat. Herb.); Jul. 1888, fr. (Gray Herb.); May, 1893, fl. (U. S. Nat. Herb.).

[2] Hara in Nakai & Honda, Nova Flora Japonica, No. 3: 82–117 (1939).

[3] *C. alternifolium* var. *sibiricum* Seringe in DC. Prodr. 4: 48 (1830).

The following are representative specimens from Asia which are considered conspecific with *C. iowense* of North America.

SIBERIA, *Fischer* misit, Jul. 1825 as *C. sibiricum* Steph. (Gray Herb.); Waigatsch, sinus Warnek, *Ekstam*, 9/8, 1902 (New York Bot. Gard.). SOUTH KAMTCHATKA: Bolsheredsk, *Hultén* 2057, Jul. 8, 1921 (Gray Herb.). MANCHURIA: Khingan Mts., *Yamatsuta*, Jun. 1930 & 1931 (Herb. Sci. Mus. Tokyo). SAGHALIN: Mitliyofka, *Nakahara*, Jun. 24, 1906 (Herb. Univ. Tokyo). Kawakita, *Sugawara*, May 1, 1925 (Herb. Hara). HOKKAIDO: Bihoro, Kitami, *Tomooka*, May 1, 1936 (Herb. Hara); Kiritap, Kushiro, *A. Kimura*, May 21, 1931 (Herb. Hara); Nemuro, leg.?, May 6, 1911 (Herb. Univ. Tokyo).

It is certain that, so far as American materials are concerned, Dr. Rosendahl's statement that *C. iowense* is quite distinct from *C. alternifolium* from Europe is correct. The same is equally true when the above cited specimens from Asia are compared with European *C. alternifolium*. In Eurasia, however, the problem is not so simple. As Dr. Rosendahl has also suggested, *C. iowense* is no doubt closer to *C. alternifolium* than to other species, and some specimens from Asia seem to show variations toward *C. alternifolium*. In the European Alps too, there are forms which closely resemble to *C. iowense* in general appearance. So it is not safe to assert that *C. iowense*, including Asiatic plants, is specifically distinct from *C. alternifolium* before more sufficient material from Eurasia, especially from Siberia, can be examined. It was for this reason that I treated this entity as a geographical variety of *C. alternifolium* in 1939.—HIROSHI HARA, Botanical Institute, Faculty of Science, University of Tokyo, Hongo, Tokyo.

ERRORS OF CITATION IN AGROSTIS AND CONVOLVULUS.—Mr. Haskell Venard kindly calls to my attention a *lapsus* in making a transfer in *Agrostis*. The emended combination is as follows:

AGROSTIS ALBA L., forma **aristigera** (Fernald), comb. nov. *A. stolonifera* L., forma *aristigera* Fernald in RHODORA, XXXV. 317 (1933). *A. alba* L., forma *aristata* Fernald in RHODORA, xlix. 112 (1947), *lapsus calami*.

Although there is the name, without a word of description, *Agrostis alba* L., forma *aristata* Millspaugh, Fl. W. Va. (W. Va.

Agr. Expt. Sta. Bull. no. 24), 469 (1892), that name is invalid, because a *nomen nudum.*

In Rhodora, li. 71 (footnote) (1949), I cited the name *Convolvulus sepium*, var. *repens* as starting with Coleman. Miss Stone notes that Coleman's initial "*C*" stood for *Calystegia.* The author of *Convolvulus sepium*, var. *repens* is Gray.—M. L. Fernald.

CONTRIBUTIONS FROM THE GRAY HERBARIUM OF HARVARD UNIVERSITY—NO. CLXX

THE AMERICAN BARBISTYLED SPECIES OF TEPHROSIA (LEGUMINOSAE)

Carroll E. Wood, Jr.

(Plates 1152–1155)

Introduction

Although the name *Tephrosia* has been used for a genus of moths, it is perhaps more familiar to biologists for a large genus of several hundred species of plants, members of the Tribe Galegeae, Family Leguminosae, widely distributed in warm-temperate and tropical regions. Many of these species produce rotenone and related compounds, so that the group is not only of economic importance as a potential source of insecticides non-poisonous to mammals, but also of ethnological interest in connection with the capture of fish by poisoning. Nevertheless, since the time of DeCandolle no attempt has been made to consider the genus as a whole and even regional monographs have been few and, for the most part, inadequate. To those who have attempted to determine specimens on the basis of existing treatments the need for a revision of the genus should be evident. The high percentage of misidentified specimens in herbaria and the confusion in anthropological, entomological and chemical literature in connection with the use of various species of *Tephrosia* as fish-poisons and insecticides are further indications of the desirability of re-examination of the genus. The large number of species involved, however, and the lack of workable, well-established subgeneric divisions necessitates a piecemeal approach on a regional basis.

Although it was originally intended to attempt a taxonomic revision including all of the North American species, the problem was later recast to deal with only a part of the species of both American continents. This change in emphasis resulted when it became evident that the New World species of *Tephrosia* fall into two rather natural groups: those with glabrous styles and those with bearded or barbate styles. The species with glabrous styles make up a particularly vexing assemblage which it has been impossible to revise in a consistent manner with the information now available. The other group, however, is more amenable to revision, contains a wide range of morphological types and offers a more suitable point for attacking the genus. This paper is limited, therefore, primarily to a survey of the larger, barbistyled group which in the New World occurs principally in North America, with two representatives extending into South America. Various references are made, however, to species with glabrous styles, while much of the general discussion applies to all of the American species; and a list of the names excluded by this style-character is placed at the end of the revision.[1]

Some ninety described species and varieties and many more nomenclatural combinations are involved in the barbistyled group, but a high mortality of binomials in this work leaves the New World with 45 endemic species (including 7 previously undescribed), 2 naturalized exotics and 2 apparent waifs. I do not think, however, that this is needless "lumping," but that specific boundaries are, as a result, more natural and distinct, with the species themselves established on more stable bases than in the past, even though there remain many points of doubt and much to be done, while the interrelationships of most species are anything but clear.

Although almost everyone will agree that in any taxonomic study of a group of plants it is desirable to use information derived from all aspects of the plants and their biology, with some groups certain lanes of approach are, of necessity, either closed or limited until other obstacles are cleared away. It is obvious that it is first necessary to work out a system of interrelationships based on the accumulated information in herbaria with such

[1] For clarity all species belonging to the glabrous-styled group will be marked by an asterisk (*) wherever mentioned in connection with barbistyled species.

geographical and ecological data as may be available. With this as a beginning, further enlightenment may be sought with the aid of more extensive field-study of populations and their ecology, along with anatomical, cytological, genetic and physiological studies. With the additional information thus painfully obtained, the original taxonomic treatment may be remodeled into a more natural one. It is essential first, however, to have some rough outline from which to work.

The revision of the New World barbistyled Tephrosias attempted here is in the nature of that rough outline with a few beginnings of more detailed studies. The approach has been primarily morphological and geographical, with herbarium-specimens as a basis. I have, however, taken the welcome opportunity of escaping from the herbarium to study in the field a number of the species of the United States and Mexico, so that my acquaintance with the genus is not entirely second-hand. A beginning has also been made in the use of cytological data and some anatomical information has been obtained. Unfortunately, the inaccessibility of the regions in which many of the plants grow, the impossibility of obtaining seeds of more than half of the species, the relatively slow growth, deep tap-roots and perennial habit and, particularly, the difficulties of cultivation of most species in the northern part of the United States have precluded environmental manipulations and genetic experiments. In addition, a number of the species from the poorly explored mountains of western Mexico are represented by only one or a few collections, mostly with scanty field-data, so that the distribution, range of variation, flower-color, fruit and seeds are poorly understood or completely unknown. This beginning is presented, however, without apologies, but with the usual hope that it will indicate some of the problems involved and lead to further, more complete, studies of the genus.

Acknowledgments

It is a pleasure to acknowledge the assistance of the many people without whose interest this study would never have been brought to its present state. I am greatly indebted to Professor M. L. Fernald who suggested the problem and under whose direction the work was begun. The revision has been completed

through the guidance, helpful criticism and enthusiastic interest of Professor Lincoln Constance to whom I am especially grateful. Professor I. W. Bailey has displayed a keen interest in the morphological and anatomical aspects of the work and has kindly demonstrated various techniques for me. The late Mr. C. A. Weatherby gave generously, as always, his kindly advice and assistance in nomenclatural problems. I am grateful to Dr. Bernice G. Schubert, Dr. R. C. Foster, Dr. H. E. Moore, Jr., and Miss Ruth D. Sanderson, of the Gray Herbarium, for their assistance with many perplexing matters which have arisen. Dr. Earlene Atchison, of the University of North Carolina, suggested the cytological technique used and gave me much helpful advice on this subject. Dr. E. Lucy Braun, of the University of Cincinnati, has kindly allowed me to study the collections of *Tephrosia* in her private herbarium and I have had the privilege of examining the herbarium of Mr. Ira W. Clokey deposited at the University of California. Mr. A. G. Olsen and Mr. H. N. Cooledge, Jr., aided materially in the preparation of some of the maps. At the University of California, where the work was completed, I have had the welcome advice and help of many friends. The careful collections kindly made by Miss Annetta Carter in Baja California in the spring of 1949 have been very helpful in resolving several problems.

Particular acknowledgment is due for the assistance given me by Harvard University through an Atkins Scholarship in 1947 and a Parker Fellowship in Biology in 1948–49. The first enabled me in the summer of 1947 to undertake field-studies with Dr. and Mrs. I. D. Clement on the southeastern Coastal Plain and then in Cuba, where a month was spent at the Atkins Garden and Research Laboratory of Harvard University at Soledad, near Cienfuegos. I am indebted to Dr. A. G. Kevorkian, then Director, for many favors during the stay at Soledad. As a Parker Fellow in 1948, I was able to spend two months in field-study in Mexico with Dr. H. E. Moore, Jr., now of the Bailey Hortorium, Cornell University. Data and seeds from numerous species of *Tephrosia* studied in the western Sierra Madre have resulted in the clarification of a number of problems.

The curators of the following institutions (designated in the

text by the initials here given[1]) have generously permitted me to borrow extensively from the abundant material in their care:

A	Arnold Arboretum, Harvard University
CAS	California Academy of Sciences
DS	Dudley Herbarium, Stanford University
DUKE	Duke University
F	Chicago Natural History Museum
FLAS	Agricultural Experiment Station, University of Florida
GA	University of Georgia
GH	Gray Herbarium, Harvard University
ISC	Iowa State College
K	Royal Botanic Gardens, Kew
KSA	Kansas State Agricultural College
KY	University of Kentucky
MEXU	Instituto de Biologia, Universidad Nacional de México
MIAMI	Buswell Herbarium, University of Miami, Coral Gables
MO	Missouri Botanical Garden
NEBC	New England Botanical Club
NY	New York Botanical Garden
OKL	University of Oklahoma
PH	Academy of Natural Sciences of Philadelphia
PHBC	Philadelphia Botanical Club
POM	Pomona College
SMU	Southern Methodist University
TENN	University of Tennessee
TEX	University of Texas
UC	University of California (including the Clokey Herbarium)
US	United States National Herbarium
WVA	West Virginia University

Historical Account

The confused history of *Tephrosia* as a genus began with Linnaeus who, in the first edition of *Species Plantarum* (1753), set off the genus *Cracca* with six species, all of which are currently recognized as species of *Tephrosia*. Later, however, he doubted the distinctness of *Cracca* and merged it with *Galega* (Linnaeus 1759, p. 1172),[2] where it remained in obscurity until resurrected by Kuntze in 1891.

After Linnaeus numerous species were described under *Galega* (which became more or less a catch-all) and at least four other generic names were applied to plants now included in *Tephrosia*. The genus *Tephrosia* itself was proposed as segregate from *Galega* by Persoon (1807, pp. 328–330) who transferred into it a rather heterogeneous series of species, including the original *Craccae* of Linnaeus (and related species) as well as plants now

[1] Most of the abbreviations adopted are those suggested by Lanjouw (1939, 1941).

[2] In a footnote he explains, "Galegam 770 & Craccam 795 *genere sub eodem comprehendi docuere recentiores observationes*".

recognized as belonging to very different genera. Although *Tephrosia* Pers. was thus a superfluous name (including as it did *Cracca* L.), it was adopted by most writers and the extraneous elements gradually removed to other genera, leaving the genus taxonomically essentially as now understood and nomenclaturally synonymous with *Cracca* L.

Some of the last of the discordant elements included in *Tephrosia* by Persoon were removed by Bentham (1853) who erected for them an entirely new genus *Cracca*[1], based on *Galega caribaea* Jacq., a plant morphologically quite different from true *Tephrosia* Pers. (*Cracca* L.). The situation was still further complicated by the appearance of a third genus *Cracca* when Alefeld (1861), agreeing with Grenier and Godron (1848), revived the pre-Linnaean *Cracca* Riv. (1691)[2] for a portion of *Vicia* L. Adopting the view that this earlier use of the name necessitated new names for both *Cracca* L. and *Cracca* Benth., Alefeld (1862) continued the use of *Tephrosia* Pers. for the former and proposed a new name, *Benthamantha*, for the latter. Most authors, however, either overlooked or ignored Alefeld and continued to use *Tephrosia* Pers., *Cracca* Benth. and *Vicia* L. (*sens. lat.*). Finally, to make the confusion complete, Kuntze (1891), on the basis of priority, adopted *Cracca* L. for *Tephrosia* Pers., transferred all the known species of *Tephrosia* to that genus and, apparently not knowing of Alefeld's *Benthamantha*, proposed yet another name, *Brittonamra*, for *Cracca* Benth.

Cracca [Riv.] Medic. has not seriously been considered as a genus since Alefeld, but *Cracca* L. and the very different *Cracca* Benth. have inevitably been badly tangled nomenclaturally. Although *Tephrosia* Pers., which had been widely used for almost a hundred years, was conserved over both *Cracca* L. and *Cracca* Medic. by the International Botanical Congress of 1905 and was again included in the list of *nomina conservanda* in 1910, adherents to the American Code continued to recognize *Cracca* L. as the proper name for the genus. *Cracca* Benth.,

[1] Although the name is usually cited as of Benth. ex Oerst., both Bentham and Oersted are the authors of this paper. The proper citation is *Cracca* Benth. ex Benth. & Oerst.

[2] Although these authors attributed the genus to Rivinius, under the present rules this is properly *Cracca* Medic. Vorles. Churpf. Phys. Ges. 2: 359. 1787, which was proposed as a segregate from *Vicia* L., based on *V. Gerhardi* Jacq., *V. benghalensis* L. and a new species, *C. syriaca*. It is treated by most authors as a section of *Vicia* L. or as a synonym under that genus.

twice a later homonym, became *Benthamantha* Alef. However, with the demise of the American Code the conservation of *Tephrosia* was again confirmed (Briquet 1935) and has been generally accepted.

Cracca Benth. has now been proposed and accepted for conservation (Rehder et al. 1935; Sprague 1940), but has not yet been acted upon by a Botanical Congress. The proposed conservation of this name which, although rather generally accepted until fifty years ago, has since become surrounded by an aura of confusion, at least in the United States, would not seem to contribute to nomenclatural clarity. It would appear better to eliminate the name completely and to continue to use *Benthamantha* Alef. There could then be no doubt as to which genus was intended. It is to be hoped, however, that, should *Cracca* Benth. be approved as a conserved name by the next International Botanical Congress, the confusion will abate in time.

The nomenclatural confusion aside, *Tephrosia*, as a genus, has been the subject of relatively few treatments. No attempt has been made since A. P. DeCandolle (1825, pp. 248–256) to monograph the genus on a world-wide scale, although several regional works have treated it in part. E. G. Baker (1926) revised the species of tropical Africa, recognizing 146 species, many of which were based on variable pubescence-characters. According to an excellent recent monograph (Forbes 1948), 67 species are known from South Africa. The most recent monograph of the Australian species is that of Domin (1926, pp. 746–756) who concluded that 23 species occur in that continent. The Asiatic species have not yet, to my knowledge, been treated as a group.

Although numerous short papers concerned with North American Tephrosias have been published, only four have dealt with these at any length. The first was a "Revision of the North American Species of *Cracca*" by Anna Murray Vail (1895). She concluded that 14 species and 3 varieties occurred in "North America" (i. e., the United States). Four years later B. L. Robinson (1899), dissatisfied with Miss Vail's work, published a somewhat more useful "Revision of the North American Species of *Tephrosia*," still restricting North America to the United States and including 12 species and 5 varieties. A further treat-

ment of importance was not forthcoming until Standley (1922) brought together in his "Trees and Shrubs of Mexico" much of the available information concerning 26 Mexican species.

It remained, however, for Rydberg (1923) to monograph the species occurring in North America, including the West Indies. This work, in which he treated 72 species, 16 of which were described as new, is far from satisfactory, for many of the specific descriptions are little more than rewordings of the original, usually inadequate diagnoses, the keys contradict both themselves and the descriptions, and the specific lines are often finely drawn and based entirely on such inconstant characters as pubescence of the vegetative organs. Rydberg's herbarium annotations follow the outlines of his monograph and indicate that he did not clearly understand many of the entities with which he was dealing. However, handicapped though he was by the relatively few specimens then available and by his extreme tendency toward "splitting", his work remains to date the only outline of the North American species. About 50 of the 72 species given by Rydberg appear to represent "good" species.

Various notes concerning South American species have been published, but apparently nothing dealing expressly with these as a group has appeared. Bentham in Martius, Fl. Bras. **15** (1): 46–50. 1859, recognized 7 species in Brazil. Comments on the genus in Brazilian Amazonia are included in Ducke's work (1939) on the legumes of that region and Burkart (1943) records 3 species from Argentina in his study of the legumes of that country. A number of species were dismembered by Chodat and/or Hassler in various publications.

Economic Importance

Various species of *Tephrosia* have been used as fish-poisons in the Americas, Africa, Asia and Australia. It is remarkable that primitive peoples in such isolated parts of the world, lacking any apparent communication with one another, have discovered and domesticated species of the same genus for the same purpose, the poisoning of fish. The species most frequently mentioned in this connection are *Tephrosia Sinapou* in the Caribbean area and South America, *T. multifolia* and *T. Sinapou* in Central America,

T. Vogelii and *T. macropoda* in Africa, and **T. rosea* and **T. astragaloides* in Australia.

An early account of fish-poisoning with *Tephrosia Sinapou* in Jamaica illustrates the general method used in capturing fish:

> The leaves and branches of this plant, being well pounded and thrown into any river, pond, or creek, are observed to infect the waters very soon: by which all the fish are immediately intoxicated and rise and float upon the surface, as if they were dead; from whence they are easily taken. But most of the large ones that are left recover from this trance, after a short time: tho' the greatest part of the small fry perish on those occasions (Browne 1756, p. 296).

Although in this instance the shoots are toxic to fish, in other species only the roots are used, the foliage being completely harmless. *Tephrosia Sinapou* appears to have been widely cultivated in the Caribbean region in pre-Columbian times and even later. Browne (1756) notes that it was "introduced to *Jamaica* from the main", and was "cultivated in many parts of the island, on account of its intoxicating qualities". With the near extinction of the Indians of the Caribbean, however, the plant has become rare in the West Indies, although it is still widely cultivated in South America as a fish-poison.

Some species have long been used by primitive peoples as insecticides, as well as fish-poisons, and in recent years have come to the attention of economic entomologists and chemists. The toxic qualities of these plants are due to the presence of rotenone, deguelin and related compounds which are chemically identical with those found in *Derris* and *Lonchocarpus*, the commercial sources of rotenone. They are not, however, present in such large quantities as in those plants, and this factor limits the commercial exploitation of *Tephrosia* species at the present time. The maximum rotenone- and deguelin-content of *Tephrosia virginiana*, for example, is about 4 per cent, whereas Derris and *Cube* often contain 10 per cent or more (Roark 1937).

Nevertheless, rotenone has become so important as an insecticide non-poisonous to mammals that extensive surveys have been conducted by the U. S. Department of Agriculture to determine the feasibility of cultivating native species as commercial sources. In 1934 and 1935, many of the species of the southeastern United States were tested, but only *Tephrosia virginiana* (including *T. latidens*) appeared to be promising (Sievers, Russell et al.

1938). As a result, cultural experiments in the United States have been confined to this species.

In the course of one of these surveys (1935), plants of *Tephrosia virginiana* from many localities from Virginia southward and westward were tested for the presence of rotenone. Large areas were found to lack completely any toxic plants, but plants with relatively high rotenone content were found in light, sandy soils in northeastern and western Florida, and in northeastern Texas within a narrow belt extending some 300 miles between Caldwell and Harrison counties. Secondary districts were located in Georgia, Louisiana, Texas and Oklahoma. The evidence accumulated at that time suggested that the presence of toxic substances was controlled by genetic factors, the expression of which was affected by the environment, particularly edaphic conditions (Sievers, Russell et al. 1938). Transplant-experiments have since indicated that the controlling factors are indeed hereditary, for plants with high rotenone-content retain their toxicity when transferred to a region yielding only mediocre material, and also when transferred from one soil-type to another. It has also been shown that highly toxic plants tend to produce offspring of similar toxicity (Little 1942).

Tephrosia virginiana responds well to cultivation in sandy soils, requiring little attention and giving economically promising yields. The roots, in addition to producing rotenone[1], harbor nitrogen-fixing bacteria. The leaves and stems of this species are non-toxic and have some value as hay.

A great mass of technical literature concerning the use of *Tephrosia* as an insecticide has accumulated in the last 20 years. The portion up to 1937 has been thoroughly reviewed by Roark (1937). A more general account up to 1941 of the literature concerning plants of possible insecticidal value has been given by McIndoo (1945).

Tephrosia species have also been utilized in tropical agriculture as green manures, cover-crops, soil-binders and contour-hedges. Most of the species so used are native to the Eastern Hemisphere, although "*Tephrosia toxicaria*" (either *T. Sinapou* or *T. multifolia*) has been grown as a green manure in the Nether-

[1] Rotenone is found concentrated in the xylem and not in the bark. All roots contain the same proportion of toxic substances regardless of size (Sievers, Russell et al. 1938).

lands Indies. **Tephrosia noctiflora* appears to have been introduced into the West Indies as a cover-crop, as perhaps was *T. candida.*

Various medicinal properties have been assigned to *Tephrosia* species. Among these may be mentioned the use of the roots of *T. virginiana* as a vermifuge by the Indians of eastern North America (Griffith 1847; Rafinesque 1830). The purgative propties of **T. Senna* HBK. (*T. cathartica*) are further commemorated by the common name "Wild Senna" in the British West Indies.

The ornamental possibilities of *Tephrosia* have been little explored, although *T. Vogelii* is cultivated in tropical Africa both as a fish-poison and as an ornamental shrub. *Tephrosia macrantha,* a shrub of western Mexico with large attractive flowers and a long blooming period, would probably make a very desirable cultivated plant in frost-free regions.

Cytology

In addition to the usual morphological characters, an attempt was made to utilize the chromosome-numbers of some of the species of *Tephrosia* as a systematic criterion. More data of this type seemed to be particularly desirable since Senn (1938), in reviewing the chromosomal relationships within the Leguminosae, had indicated that the genus was evidently in need of careful chromosomal, as well as taxonomic, study.

Efforts were made in the summer of 1947 to secure counts of meiotic chromosomes, particularly those of **Tephrosia cinerea*, at the Atkins Garden and Research Laboratory at Soledad, Cuba. These attempts were all unsuccessful, probably because of the sporadic flowering of the inflorescence. The available species of the southeastern United States proved equally difficult. In consequence, chromosome counts from root-tips have been relied upon exclusively.

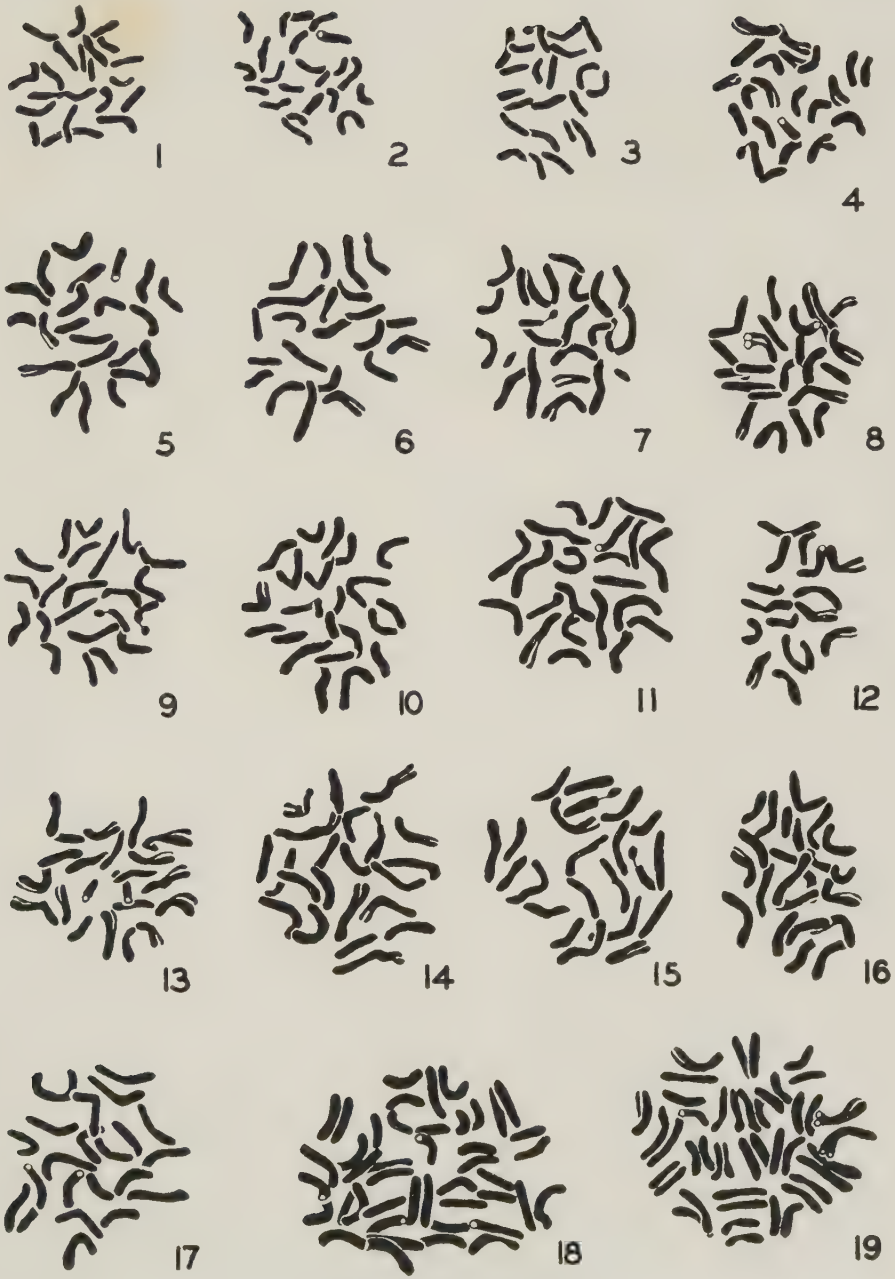
Mature seeds of seven species of *Tephrosia* were collected in the southeastern states and seeds of **T. cinerea* in Cuba in 1947. In 1948, 3 more species were added from Texas and Mexico. At Soledad fresh, nearly mature but still quite green seeds of **T. cinerea* germinated immediately in moist Petri dishes, producing vigorous root-tips. In addition, seeds taken from herbarium-specimens have, in many instances, germinated readily. Perma-

nent slides were prepared[1] and chromosome-counts obtained for 27 species. The diploid number is 22 in all. (See Table 1 and Plate 1152).[2]

The chromosome-numbers of only two species have been recorded previously. These are "*T. Hookeriana* W. & A." (probably = *T. villosa* (L.) Pers.), n = 16, according to Kawakami (1930) and *T. virginiana* (L.) Pers., n = 11, reported by Senn (1938, p. 231). The occurrence of these two numbers within the genus was pointed out by Senn as remarkable, particularly since 11 was a number unknown elsewhere within the Tribe Galegeae, 8 being the basic number of most genera. Since then, however, 13 species with 11 pairs of chromosomes have been reported in *Astragalus* (Vilkomerson 1943), a genus previously believed to have only 7 and 8 as the basic numbers, so that the occurrence of 8 and 11 in *Tephrosia* would not necessarily be particularly remarkable. The counts of 27 species of *Tephrosia*, all with 22 somatic chromosomes, suggest, moreover, that the genus is probably very uniform in chromosome-number and strongly indicate that the reported haploid number of *T. Hookeriana* is erroneous. Since the species counted represent a wide range of morphological types, including three Old World species (one presumably a close relative of *T. Hookeriana*), it is likely that these results are fairly conclusive, except for the possibility of polyploid species. To

[1] The seed-coats of dry, mature seeds were sterilized by immersion in 70 per cent alcohol for a few minutes and scarified with a scalpel. The seeds were then rinsed in sterile distilled water and placed on moist filter-paper in sterile Petri dishes. Imbibition of water took place rapidly and germination often followed overnight. Root-tips were stained whole by the Feulgen technique following Belling's or Randolph's fixative, embedded in paraffin via ethyl alcohol and chloroform, sectioned at 10 microns, affixed to slides, passed through xylene to remove the paraffin and finally mounted in balsam. Good results are difficult to obtain in this group with any of the various smearing or "squashing" techniques. Drawings of the chromosomes were made with camera lucida, oil-immersion objective (90x) and 20x compens oculars. Counts are documented by specimens in the herbaria indicated in Table 1.

[2] Plate 1152. Somatic Chromosomes of *Tephrosia* and *Sphinctospermum*. Mitotic figures from root-tips. Figure 4 ca. 2750 ×, all other figures ca. 2600 ×. All documenting specimens in (GH). 1. **Tephrosia vicioides* (Purpus 8171); 2. **T. tenella* (Gentry 4684); 3. **T. noctiflora* (Archer 2557); 4. **T. angustissima* (Wood & Clement 7492); 5. *T. virginiana* (Wood & Clement 7605); 6. *T. Sinapou* (Pringle 11436); 7. *T. Conzattii* (Hinton 6998); 8. *T. foliolosa* (Gentry 5279); 9. *T. nitens* (Hinton 11037); 10. *T. belizensis* (Schultes & Reko 552); 11. *T. spicata* (Wood & Clement 7531); 12. *Sphinctospermum constrictum* (Gentry 4676); 13. *T. hispidula* (Wood & Clement 7194); 14. *T. florida* (Wood & Clement 7596); 15. *T. chrysophylla* (Wood & Clement 7172a); 16. *T. Rugelii* (Wood & Clement 7512); 17. *T. florida* (topotype of *T. gracillima*) (Wood & Clement 7202); 18. *T. chrysophylla*, tetraploid cell (Wood & Clement 7525a); 19. *T. Rugelii*, tetraploid cell (Wood & Clement 7512).



Explained in footnote, p. 204

TABLE 1

Chromosome-Numbers of *Tephrosia*, *Cracca* and *Sphinctospermum*

Species	2n	Collection	Year	Locality
T. multifolia	22	Rose, Standley & Russell 14227 (GH)	1910	Nayarit
	22	Calderón 2611 (F)	1933	El Salvador
T. foliolosa	22	Gentry 5279 (GH)	1939	Durango
T. Sinapou	22	Pringle 11436 (GH)	1903	Jalisco
T. leiocarpa	22	Gentry 4894 (GH)	1939	Sonora
T. Conzattii	22	Hinton 6998 (GH)	1934	México (State)
	22+2f			
T. virginiana	22	Wood & Clement 7605 (GH)	1947	South Carolina
	22	7613 (GH)	1947	North Carolina
T. onobrychoides	22	Moore & Wood 3616 (GH)	1948	Texas
T. rhodantha	22	Hinton 11641 (GH)	1937	Guerrero
T. cana	22	Carter, Alexander & Kellogg 2406 (UC)	1947	Baja California
	22	Gentry 4366 (DS)	1939	Baja California
T. Palmeri	22	Gentry 3718 (MO)	1938	Baja California
T. Rugelii	22	Wood & Clement 7170 (GH)	1947	Florida
		7512 (GH)	1947	Florida
T. spicata	22	Wood & Clement 7178 (GH)	1947	Florida
	22	7531 (GH)	1947	Florida
	22	7608 (GH)	1947	North Carolina
T. hispidula	22	Wood & Clement 7194 (GH)	1947	Florida
	22	7547 (GH)	1947	Florida
T. florida	22	Wood & Clement 7089 (GH)	1947	South Carolina
	22	7202 (GH)	1947	Florida
	22	7527 (GH)	1947	Florida
	22	7532 (GH)	1947	Florida
	22	7560 (GH)	1947	Georgia
	22	7565 (GH)	1947	Georgia
	22	7596 (GH)	1947	South Carolina
	22	7598 (GH)	1947	South Carolina
	22	7607 (GH)	1947	North Carolina
T. chrysophylla	22	Wood & Clement 7172a (GH)	1947	Florida
	22	7525a (GH)	1947	Florida
T. Lindheimeri	22	Moore & Wood 3617 (GH)	1948	Texas
T. potosina	22	Moore & Wood 3618 (GH)	1948	Nuevo León
T. nitens	22	Hinton 11037 (GH)	1937	Guerrero
T. belizensis	22	Schultes & Reko 552 (GH)	1939	Oaxaca
T. grandiflora	22	Orcutt 3235 (UC)	1927	Jamaica
T. Vogelii	22	No voucher; identified from seeds only, but these unmistakable.	1946	Cultivated, Bianchi, Guatemala
**T. cinerea*	22	Wood 7537 (GH)	1947	Cuba
**T. Senna*	22	Rose et al. 3228 (GH)	1913	St. Kitts, British West Indies
**T. tenella*	22	Gentry 4684 (GH)	1939	Sonora
**T. angustissima*	22	Wood & Clement 7492 (GH)	1947	Florida
**T. vicioides*	22	Purpus 8171 (GH)	1918	Veracruz
**T. noctiflora*	22	Archer 2557 (GH)	1934	Cultivated, British Guiana
Cracca sp.	16	Hinton 8740 (GH)	1935	México (State)
Sphinctospermum constrictum	16	Gentry 4676 (GH)	1939	Sonora

* Styles glabrous.

date, no polyploids have been found, although a few tetraploid cells were encountered in the roots of *T. chrysophylla*, *T. florida* and *T. Rugelii* (Pl. 1152, fig. 18, 19). Such polysomatic cells have been found more or less irregularly, both in the roots of a number of leguminous genera (Atkinson 1948; Vilkomerson 1943) and in various tissues of other families as well, and may be a normal feature of differentiated tissues (Huskins 1948).

The apparent uniformity of chromosome-number in *Tephrosia*, at least in the Western Hemisphere, is disappointing at the species-level, but is interesting as a generic character. Few of the supposedly related genera have been studied cytologically, but two species of *Galega* have been reported with 8 pairs of chromosomes (Kreuter 1929, 1930; Senn 1938). A single species of *Cracca* and the monotypic *Sphinctospermum* also have 8 pairs, although neither of these genera is particularly closely related to *Tephrosia*. The presence of 8 pairs of chromosomes in *Sphinctospermum* is especially interesting, since this plant was originally described as a *Tephrosia* by Sereno Watson. Rose erected a new genus for it on morphological grounds; the chromosome-numbers strengthen this already strong segregation. In both morphology and chromosomes it is much more closely related to *Cracca* Benth. than to *Tephrosia*.

With the amount and type of material now available it seems unwise to attempt to utilize chromosome-morphology as a comparative character. From a glance at Plate 1, however, it will be evident that the chromosomes of at least some of the glabrous-styled species are noticeably smaller than those of barbistyled species and that satellites are present on two chromosomes. Unfortunately, although the satellites are large, they are seldom visible, even in species in which they have definitely been observed. It may also be noted that absolute chromosome-size varies considerably from one cell to another within the same root-tip. In addition, one possible example of ageing in 15-year-old seeds of *Tephrosia Conzattii* is found in the appearance of 22 chromosomes plus 2 fragments in dividing cells of one seedling root-tip (Plate 1152, fig. 7). A second root-tip had 22 apparently "normal" chromosomes.

Longevity of Seeds

Incidental to securing root-tips for chromosome-counts, a few data concerning the longevity of seeds of *Tephrosia, Cracca* and *Sphinctospermum* have accumulated. The results from herbarium-collections are given in Table 2; freshly collected seeds usually give almost 100 per cent germination. While the quantities of seeds employed are too small to be statistically significant, the results are interesting in that they conform to the findings of Becquerel, Ewart, Turner, Schelderup-Ebbe and others that seeds of Leguminosae are relatively resistant to ageing and retain the power of germination for long periods.

It is of interest to note that the seeds used in the present experiments were taken from specimens which, at least in the Gray Herbarium, have been stored for the periods indicated in a very dry, steam-heated building. These have, in addition, been fumigated with carbon bisulfide at least twice. That any seeds at all germinated attests to the impervious nature of the seed coats.

In the fall of 1948, 15 seeds of *Tephrosia potosina* and 5 of *T. onobrychoides* (*Moore & Wood 3618* and *3616*, respectively) were subjected to the heat-treatment newly initiated at the University of California to rid herbarium-specimens of insects. In this process the temperature of an insulated room containing the specimens is raised slightly above 60° C. for about 12 hours and then allowed to return slowly to normal. All insects are destroyed by this treatment, but all 20 of the fresh seeds were apparently unharmed and germinated immediately.

These data from *Tephrosia* hardly compare, however, with records of Becquerel and Ewart of old seeds kept in herbaria or seed-cupboards. Crocker (1938) has summarized their material in reviewing the literature concerning the life-span of seeds. The following are the oldest definitely known records, all from leguminous species except the last:

Cassia bicapsularis L.	115 years old	40%	germination
Cassia multijuga Rich.	158	100%	
Goodia lotifolia Salisb.	105	7.7%	
Hovea linearis R. Br.	105	17%	
Nelumbo nucifera L.	150	85%	

Other records of Becquerel, Ewart, Turner and Schelderup-Ebbe as given by Crocker show several additional legumes re-

TABLE 2

Longevity of Seeds of *Tephrosia*, *Cracca* and *Sphinctospermum*

Species	Collection	Year	Age at test	No. tested	No. germinated	% germination
**Tephrosia tenella*	Hinckley 2959 (GH)	1944	3 yrs.	3	3	100
**T. tenella*	Gentry 4684 (GH)	1939	8	2	2	100
Sphinctospermum constrictum	Gentry 4676 (GH)	1939	8	5	5	100
T. belizensis	Schultes & Reko 552 (GH)	1939	8	4	4	100
T. foliolosa	Gentry 5279 (GH)	1939	8	2	1	50
T. cana	Gentry 4366 (DS)	1939	8	1	1	100
T. leiocarpa	Gentry 4894 (GH)	1939	8	5	4	80
T. Palmeri	Gentry 3718 (MO)	1938	10	2	2	100
T. nitens	Hinton 11037 (GH)	1937	10	2	1	50
T. rhodantha	Hinton 11641 (GH)	1937	10	5	5	100
Cracca sp.	Hinton 8740 (GH)	1935	12	4	3	75
T. Conzattii	Hinton 6998 (GH)	1934	13	5	1	20
**T. noctiflora*	Archer 2557 (GH)	1934	13	5	2	40
T. multifolia	Calderón 2611 (F)	1933	15	6	5	83
T. grandiflora	Orcutt 3235 (UC)	1927	21	6	4	66
T. multifolia	Standley 20463 (GH)	1922	25	10	1	10
**T. vicioides*	Purpus 8171 (GH)	1918	29	13	6	46
**T. Senna*	Rose et al. 3228 (GH)	1913	34	3	2	66
T. multifolia	Rose, Standley & Russell 14227 (GH)	1910	37	9	1	11
T. Sinapou	Pringle 11436 (GH)	1903	44	4	2	50
T. leiocarpa	Pringle 11434 (GH)	1903	44	1	0	0
T. leucantha	Palmer 745 (GH)	1898	49	4	0	0
T. leiocarpa	Palmer 594 (GH)	1886	61	7	0	7
	Palmer 594 (US)	1886	62	8	1	

* Styles glabrous.

taining the power of germination after 80 years. Species with a known life-span of over 50 years include representatives of the Iridaceae, Cannaceae, Tiliaceae, Malvaceae, Euphorbiaceae, Convolvulaceae and Labiatae.

From casual observation the unsuccessful germination of *Tephrosia* seeds appeared in many instances to be due to the failure of the hypocotyl and radicle to grow. The cotyledons often remained firm and alive and in some cases expanded and became green in sunlight.

Morphology and Taxonomic Criteria

As with many genera of Leguminosae, *Tephrosia* is not distinguished by an abundance of readily utilizeable taxonomic

characters. Many parts of the plant are so variable or differ so little from one species to another that no taxonomic value can be assigned to them. Although one plant may differ from another in appearance, the problem has been one of establishing such differences on firmly objective bases. To this end as many aspects of the plant as possible have been examined. The criteria which, as a result, have been chosen are, in large part, different from those used by Rydberg and other American authors. A surprising number of characters have been found in the flowers in spite of their apparently uniform papilionaceous structure. Other characters are located in the inflorescence, fruit and some of the vegetative parts, notably the leaves. No single criterion, however, can be employed throughout the genus, so that specific delimitations are usually on the basis of varying sets of characters from one group of species to another. Notes on morphology apply primarily to the species dealt with in this revision, although much of this material will apply as well to the species with glabrous styles.

Habit.—All of the American species are perennial, although **Tephrosia tenella* apparently flowers the first year from seed and may sometimes behave as an annual plant. Both herbaceous and fruticose types are included, but almost all species are somewhat woody at the base, the herbaceous types springing from a woody crown. The erect, decumbent, or prostrate habit may be of diagnostic value, but such information is seldom included on herbarium labels. *Tephrosia chrysophylla*, for example, is always completely prostrate, but in a presumed hybrid of this species with *T. florida* the stems are prostrate while the leaves are usually ascending.

Branching of the herbaceous species is either monopodial or sympodial, but this character does not seem to be of any very fundamental importance. (See *Inflorescence* and RELATIONSHIPS.)

Roots.—A heavy, woody tap-root is present in many species, but is not often collected. In *T. hispidula* this is characteristically carrot-like, in contrast to the cylindrical roots of *T. florida* and *T. spicata*, species with which it is sometimes confused. The roots of *T. virginiana* are many, long, slender, very tough and account for the popular names "cat-gut" and "devil's shoestring".

Leaves.—In all of the American species the leaves are im-

paripinnate with from one to forty-one leaflets, the leaflet-number varying within definite limits in each species. In seedlings the lowermost leaves are few-foliolate, but the leaflets increase in number with each successive leaf until a specific limit is reached. The same is, to a large degree, true of leaves produced by older plants within a season.

Petioles are usually present on at least some of the leaves, but the length of the petiole generally decreases from the lower leaves upward. Length is, therefore, usually of little value as a diagnostic character, although it is important in distinguishing the putative hybrid, *T. chrysophylla* × *T. florida*, from its parents, both of which are extreme types. The rachis and sometimes the petiole are channeled on the upper side.

The *leaflets*, which range from narrowly linear to orbicular, from 0.5 to 18 cm. long, and from membranous to thick and leathery, are important points of recognition, once the range of variability has been determined.

More or less prominent parallel lateral veins are given off obliquely from the midrib of the leaflet in all species. The areoles formed by the veinlets between these veins are, with a few intermediate exceptions, either elongate or nearly isodiametric. This feature might appear to be correlated to some extent with the shape and width of the leaflet, but this is not necessarily so, as is evidenced by several pairs of species with leaflets of approximately the same shape and size but areoles of different shapes. The venation-type, which is usually constant within a species, is summarized in Table 3. With the exception of the few somewhat confusing intermediates, the shape of the areoles is a useful character and is, in general, correlated with the presence or absence of stomata in the upper epidermis. It will also be noted from Table 3 that these types seem to run in series of related species (which, incidentally, were determined on the basis of gross morphology before these features were studied in detail).

The presence or absence of stomata in the upper epidermis appears to be characteristic of many species. It almost goes without saying, however, that such an anatomical feature needs much more careful study with emphasis on the effect of environmental fluctuations before much dependence can be placed on it as a specific character. Nevertheless, in at least some species

this seems definitely to be a constant characteristic. The stomata of most of the species with dull, thin leaves can be seen under a strong dissecting microscope as light flecks in the dried leaflet-tissue. In these species stomata are invariably present in the upper epidermis.

Stomata are completely absent from the upper epidermis of a number of species with more or less coriaceous leaves, although in other species they may be present along the midrib only, while in still others they may be either present or completely absent (Table 3).[1] The presence or absence of stomata supplies a useful supplementary character (although one which will hardly be employed enthusiastically by most taxonomists, including myself) in distinguishing between *Tephrosia Pringlei* and *T. Seemannii* and to lesser extent between *T. Langlassei* and *T. simulans.* Without exception, in all the specimens I have seen, stomata are present in the upper epidermis of *T. Pringlei* but completely absent from that of *T. Seemannii.* This difference is correlated with elongate areoles between the lateral veins of *T. Pringlei* and nearly isodiametric areoles in *T. Seemannii.*

All leaflets are petiolulate and probably exhibit turgor-movements, particularly in connection with changes in light-intensity. Sleep-movements and orientations of the leaflets in sunlight have been observed in **Tephrosia cinerea*, **T. tenella*, *T. belizensis*, *T. nicaraguensis*, *T. rhodantha* and *T. spicata* and probably occur in all species. One specimen of *T. multifolia* (*Mexia 1113*) is noted on the label as exhibiting a slight sensitivity to touch. Stipels are always absent.

Stipules vary from setaceous to lanceolate and are either deciduous or persistent and brown or green in all the endemic species. The conspicuous, ovate, brown or reddish stipules of *T. grandiflora*, a native of South Africa naturalized in Jamaica, are a notable exception. In general stipules are too uniform, exhibiting the same variations from one species to another, to be of much diagnostic value.

[1] Large pieces of epidermis and cuticle of species with relatively rigid, coriaceous leaflets may conveniently be removed from leaflets of herbarium specimens by the method recommended by Bailey and Nast (1948). Leaflets are first boiled in water and then macerated in equal parts of 5% nitric and 5% chromic acids at 56° C. Two to four hours are sufficient for most *Tephrosia* species, depending upon the thickness of the leaflets. This method is unsatisfactory with thin-leaved species, such as *T. virginiana*, *T. Sinapou*, *T. spicata*, etc.

TABLE 3

Areoles, Stomata and Glands of Indigenous American Barbistyled Tephrosias

	Isodiametric (+), elongate (−), or intermediate (±) areoles between lateral veins of leaflets	Presence (+) or absence (−) of stomata in upper epidermis of leaflets	Presence (+) or absence (−) of glands on	
			Leaflets	Legume
1. *T. multifolia*	−	+		
2. *T. foliolosa*	−	+		
3. *T. macrantha*	−	+		
4. *T. Sinapou*	−	+	−	+
5. *T. leiocarpa*	−	+		
6. *T. Conzattii*	−	+		
7. *T. cuernavacana*	−	+		
8. *T. leucantha*	−	+		
9. *T. Thurberi*	−	+		
10. *T. virginiana*	−	+		
11. *T. onobrychoides*	−	+	−	+
12. *T. rhodantha*	−	+	−	+
13. *T. cana*	−	+		
14. *T. Palmeri*	−	+		
15. *T. Rugelii*	−	+		
16. *T. spicata*	−	+	−	+
17. *T. hispidula*	−	+	−	+
18. *T. florida*	−	+	−	+
19. *T. chrysophylla*	−	+		+
20. *T. tepicana*	+	+		
21. *T. madrensis*	+			
22. *T. Lindheimeri*	−	+	−	−
23. *T. potosina*	−, ±	+	−	−
24. *T. saxicola*	+, ±	+, −	+	
25. *T. Seemannii*	+	−	− ?	
26. *T. Pringlei*	−	+	+	
27. *T. nicaraguensis*	+	−		− ?
28. *T. submontana*	+, ±	−	+	
29. *T. nitens*	−			
30. *T. hypoleuca*	?			
31. *T. vernicosa*	+	−	+	
32. *T. pogonocalyx*	+	+, −	+	
33. *T. belizensis*	−, ±	−	+	+
34. *T. mexicana*	+, ±	+, −	+	+
35. *T. Langlassei*	+	+, −	+	
36. *T. simulans*	+	−	+	
37. *T. quercetorum*	+, ±	+	+	
38. *T. Watsoniana*	+	−, +	− ?	
39. *T. crassifolia*	+	+, −	+	
40. *T. lanata*	+	−	+	
41. *T. Abbottiae*	+	−, +	+	− ?
42. *T. pachypoda*	+	−		
43. *T. major*	+	−		
44. *T. diversifolia*	+	−		
45. *T. platyphylla*	+	−		

Indument.—The indument is of appressed, spreading, recurved or retrorse, simple bicellular trichomes, varying in length from about 0.1 mm. to 3 mm. These hairs are often somewhat bullate with the short basal cell slightly enlarged. Trichomes are present at least on the lower surfaces of the leaves, on the pedicels, the calyx, the back of the banner and the upper suture of the ovary. The hairs are often twisted and curled in four species with very large and coriaceous leaves.

Small, flat, obovate or club-shaped glandular hairs composed of 8–10 cells in a single layer occur on the leaflets and legumes of some species. These are so inconspicuous as to pass unnoticed even under a powerful dissecting microscope and unfortunately it was not until near the end of this study, when the epidermis of leaflets was examined under a compound microscope, that these were noticed. As a result, the distribution of the glands has been only partially determined (Table 3).

The wide variation in the use of terms descriptive of pubescence makes it desirable to attempt a redefinition and reapplication of most of these, at least for the purposes of this paper. It seems particularly desirable to distinguish between the "morphology" of the indument (i. e., the nature of the individual hairs and the way in which they are arranged) and the over-all effect of the pubescence. (See Constance 1949.)

In describing the morphology of the indument, six terms are most frequently used here. These indicate the approximate length of the trichomes and whether they are appressed or spreading. Strigillose, short-strigose and strigose designate appressed hairs, while the parallel series, hirtellous, hirsutulous and hirsute, indicates ascending or spreading hairs. There is, of course, no sharp line between the various lengths, but, as delimited below, these terms have proved to be of definite value.

Strigillose and *hirtellous:* with minute trichomes 0.1–0.5 mm. long.
Short-strigose and *hirsutulous:* with trichomes about 0.6–1.5 mm. long.
Strigose and *hirsute:* with trichomes more than 1.5 mm. long.
Tomentose: the indument dense, composed of relatively fine, twisted or tortuous hairs, somewhat tangled together and matted. This type occurs chiefly in *T. pachypoda, T. major, T. diversifolia* and *T. platyphylla.*
Villous: the indument of soft, often somewhat twisted, but not matted, spreading hairs more than 2 mm. long.

The terms sparse, thin, moderate and dense, although admittedly indefinite, have been employed to indicate the relative abundance of pubescence in connection with the terms above.

Such terms as sericeous (or silky), pilose, lanate (or woolly), velutinous (or velvety), shining, dull, canescent and soft are descriptive of the over-all effect of the pubescence and have been employed only in a supplementary descriptive capacity.

As a taxonomic character, pubescence was greatly over-emphasized by Rydberg, and this factor alone accounts for much of the difficulty in the use of his keys. In many species, the pubescence of the vegetative parts is either spreading or appressed and is of varying lengths. Several pubescence-types often occur within the same colony, yet some of these have been given specific or varietal rank. (See the accounts of *Tephrosia onobrychoides*, *T. spicata* and *T. virginiana*.) In some instances, however, the nature of the pubescence is a useful character in conjunction with other features of the plant. The retrorse hairs of *Tephrosia Thurberi* are, for example, correlated with very narrow, but deciduous, bracts and provide a valid criterion in the determination of fruiting specimens from which the bracts have fallen. In general, the indument of vegetative parts is variable and must be used with caution.

The pubescence of the legume and of the calyx is in some cases more stable. The length of the hairs on the ovary and legume provides a simple method for distinguishing *T. hispidula* from depauperate specimens of *T. florida*. *Tephrosia foliolosa*, a very poorly known species, is separable from *T. multifolia* by minute pubescence, all of one length, on the calyx. That of *T. multifolia* is double, both hirtellous and hirsutulous or strigillose and short-strigose.

Inflorescence.—The structure of the inflorescence is one of the most distinctive features of the genus. Inflorescences are characteristically "racemose" in appearance with the flowers either in 2's or, more commonly, in clusters or "fascicles" at one to fifty nodes. Each of these clusters is borne in the axil of a leaf or of a *primary bract* homologous with a leaf.[1] A cluster is composed

[1] The inflorescence of *Tephrosia Rugelii* shows varying degrees of the reduction of a multifoliolate leaf to a lanceolate bract. In this species, at least one and often as many as five flowering nodes of the inflorescence bear leaves. On some plants the lowermost of the leaves is an apparently normal vegetative leaf with from 9 to 15

of two to seven, or more, crowded flower buds, each of which is subtended at the base of the pedicel by a secondary bract.[1]

At least two of the buds at a node flower, while one or more may remain rudimentary. In the instances in which only two buds are present at a node, both of these flower simultaneously and anthesis proceeds centrifugally, as in *Tephrosia virginiana*, *T. Thurberi*, *T. leucantha* and *T. cuernavacana*. In those species in which 3 to 5 flowers are produced at each node, however, one of the lower buds on either side of the primary bract may open first, or both may flower together, to be followed by the third bud which lies directly behind the primary bract, and then by one or more others. In these species the flowering along the inflorescence-axis is more or less irregular, neither centrifugal nor centripetal, with the various nodes behaving somewhat independently of one another.

Although the inflorescences of many species are long and wand-like with well separated nodes, shortening occurs in varying degrees in some members of the genus. In *Tephrosia virginiana* and its allied species, the buds at a node are reduced to two plus a minute rudiment between them, and the nodes of the inflorescence are often very close together and strongly buttressed below. A similar extreme is encountered in *T. platyphylla* in which the inflorescences are very short and the buds few, while the leaflets are reduced to one or three. The inflorescence of *T. grandiflora* is composed of few flowering nodes (3 to 5), each with two functional buds and no external trace of the secondary bracts. The primary bracts are large, colored and deciduous.

The structure and flowering behavior of the inflorescence of the American species of *Tephrosia* lead to the conclusion that each cluster of buds in the axil of a primary bract or leaf represents an axillary branch-system in various degrees of reduction. Each

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leaflets. At successive nodes upward, however, the leaflet-number is reduced, eventually to a single, petiolate leaflet still with stipules at the base of the petiole. At still higher nodes the leaf and stipules sometimes appear as a deeply three-cleft bract. Eventually a single, lanceolate primary bract is found. Although all of these stages do not always occur, they do provide indications of reduction.

[1] Although the secondary bracts are in varying degrees smaller than the primary bract, in some instances the two outermost are nearly as conspicuous as the primary and may appear to be the stipules of the leaf represented by the primary bract. Cleared preparations, however, clearly show that the vascular traces of the secondary bracts are associated with those of the buds they subtend and not with those of the primary bracts.

"raceme" would then represent a complicated inflorescence, the component parts of which are more or less reduced and shortened.

The *position of the inflorescences* is usually constant in well-developed plants of a species. Three general types may be distinguished. Inflorescences may be (1) terminal or terminal and with shorter branches from the axils of the upper leaves, the terminal inflorescence being best-developed, (2) axillary or primarily so, with the axillary inflorescences first and best developed, or (3) apparently opposite the leaves and terminal (sympodial).

The first type is characteristic of 34 of the 49 species. Axillary inflorescences in this type are usually borne singly, although in *T. foliolosa* and *T. multifolia* two inflorescences are sometimes seen at one node. *Tephrosia multifolia* is somewhat doubtfully placed with this group, however, for although some specimens show well-developed terminal inflorescences, on most herbarium specimens the axillary inflorescences are evidently first and best developed.

Only axillary inflorescences are developed in *Tephrosia cuernavacana*, *T. Conzattii*, *T. lanata*, *T. crassifolia* and *T. bracteolata*. Both terminal and axillary inflorescences are sometimes developed in *T. rhodantha*, but the latter are usually first and best developed. These axillary inflorescences arise from one of the three buds which lie side-by-side in the axils perpendicular to the axis of the leaf. In *T. crassifolia* and *T. lanata* one or two short branches sometimes spring from near the base of an inflorescence or an inflorescence may be accompanied by one or two short inflorescences from the same axil.

The principal inflorescences of *Tephrosia rhodantha* and *T. bracteolata* are peculiar in that they emerge obliquely from the axils (i. e., from the side of the axil). The same type occurs in the otherwise very dissimilar **T. vicioides* Schlecht. The growth of one of the lateral buds in the axil does not seem to be responsible for this peculiar behavior, for in *T. Sinapou* and *T. Conzattii*, at least, some of the axillary inflorescences develop from one of the lateral buds, but in all cases emerge from the axil in the ordinary fashion.

In the third (sympodial) group of species, in which the inflorescences are apparently opposite the leaves or terminal, the inflorescences are actually terminal but may be overtopped by the

strong growth of an axillary branch which produces another terminal inflorescence and an axillary branch. This process may be repeated several times.

Although much has been made of the monopodial versus sympodial method of branching in *Tephrosia*, the distinction between the two is frequently finely drawn, with the additional complication of the two types of axillary inflorescences. It is, for example, frequently quite difficult to determine whether a plant of *Tephrosia onobrychoides* is monopodial or sympodial and this same difficulty is one of the limiting factors in the study of the glabrous-styled species. There is also the striking example of *T. Rugelii* which is monopodial in habit, but undoubtedly most closely related to species of the southeastern United States which are definitely sympodial. A further complication is the occurrence of oblique axillary inflorescences in very dissimilar species in the glabrous- and bearded-styled groups. Monopodial versus sympodial seems to be neither a very usable nor fundamental character within the genus as a whole.

Primary bracts may be either persistent or deciduous and vary from subulate or setaceous to broadly ovate or oval and inflated. These bracts are important taxonomic characters in some instances. Secondary bracts are usually smaller and narrower and are generally of little diagnostic importance.

Bracteoles are rarely present at the base of the calyx or on the pedicels but are regularly encountered in four very different species: *Tephrosia cana*, *T. diversifolia*, *T. Abbottiae* and *T. pogonocalyx*. One to three linear to subulate bracteoles may sometimes be found on the pedicels of *T. virginiana* and *T. Thurberi*, also.

Pedicels vary in thickness from one species to another, but characteristically elongate somewhat and thicken in fruit. Pedicel-length is a reliable character only in widely separated species.

Calyx.—The five-lobed calyx is persistent in all American species except **T. sessiliflora*, an anomalous plant in which the calyx is circumscissile at the base after anthesis. The upper lobes are usually shorter than the lowermost and are more or less united. Although in the past emphasis has been given to the length of the calyx-lobes and -tube, variation is found in the

length of the lobes within a species, so that care must be taken to include the full range. The length of calyx-lobes is, however, a useful character. Ratios of length of lobes to calyx-tube are variable, difficult of application and of little value, although the genus has been divided into subgenera partly on this basis (see Relationships). Shape of the lobes is relatively constant in most cases and furnishes an important taxonomic character.

Corolla.—All five petals of the papilionaceous corolla are clawed. The length of the claw is in some instances characteristic of a species. The banner is generally suborbicular to obovate and, in all of our species, more or less hairy on the back. A yellowish-green, apparently glandular area is present at the base of the blade within, but is frequently difficult to see in herbarium material and is seldom reported.

The wing-petals vary from oblong to obovate; the shape is not reliable. A small basal auricle is often present on the upper side of the blade near the base. The keel-petals, which are united at the outer end, may be with or without a basal auricle. For the purposes of corolla-measurement the keel is most satisfactory, for it is usually damaged least in drying and is relatively constant in length. Wings and keel are lightly coherent near the base of the blades; both are glabrous.

Corolla-color is seldom reported, but offers interesting possibilities. However, a tendency for a color-change to occur as the flowers age necessitates careful field-observation. Apparently in all of the species with a free vexillary stamen and in *T. onobrychoides* the corolla is white (or yellowish on the back of the banner), becoming pink and then carmine with age or violet in drying. The flowers of *T. leucantha* and *T. Thurberi* are white, becoming violet in age, while those of the related *T. virginiana* are bicolored with white or yellowish banner and rose wings and keel as, perhaps, are those of *T. nicaraguensis*. In contrast, the flowers of *T. Abbottiae* and three closely related species appear to be rose-purple, showing little or no change with age. The same is true of the peculiar pair of species, *T. Lindheimeri* and *T. potosina*, which have no evident close relatives. A number of other species show this same type of coloration. Data on specimens of *Tephrosia Sinapou* are confusing, but the few growing plants I have seen bore white flowers with violet markings on the

upper side of the wings near the base. The flowers of most of the glabrous-styled American species appear to be rose-purple or Liseran purple (Ridgeway) but at least one introduced species of this relationship seems to have white flowers.

Androecium.—The stamens are either monadelphous with the vexillary (uppermost) stamen free only at the base, or diadelphous with the vexillary stamen completely free from the other nine. This distinction is relatively constant and is usually observed without difficulty, although a few cases are somewhat dubious, mostly for lack of material (*Tephrosia madrensis*, *T. tepicana* and *T. bracteolata*). Interestingly enough, most of the relatively small group of diadelphous species (which have herbaceous habit and white flowers) seem to be rather closely related to each other, more so than to other members of the genus.

A more or less prominent, often two- or three-lobed thickening is frequently observed on the upper side of the vexillary stamen near the base. The margins of the staminal tube on either side of this callosity are also thickened, sometimes conspicuously so, as in *T. macrantha*, in which a knob-shaped structure is present.

Filaments and anthers are unappendaged. The anthers are uniform in size and arranged in two equal, alternating series, one above the other.

Gynoecium.—The sessile ovary is surrounded at the base within the staminal tube by a saucer- or collar-like disc characteristic of the Subtribe Tephrosiinae of the Tribe Galegeae. Four to sixteen ovules are borne along the upper suture, alternating ovules being attached to either valve. Ovule-number exhibits characteristic variations which are more or less clearly reflected in seed-number. There appears to be a tendency toward reduction in ovule-number in the genus. The 10 to 16 ovules of *T. rhodantha* distinguish it from other species of its group, while *T. Lindheimeri* and *T. potosina* at the other extreme bear but from 4 to 8. Among the smooth-styled species, **T. cinerea*, with from 10 to 12 (rarely as few as 8) ovules, is readily separated from other species, with 6 to 8.

The style may be glabrous or barbate with fine white hairs along the inner (upper) side. In all of the species with which this revision deals the style is more or less barbate. The glabrous-styled group includes all of the species with small

purple flowers, such as *T. cinerea*, *T. tenella* and *T. Senna*, as well as the very aberrant *T. sessiliflora*. In all species the stigma is terminal, small and penicillate. Tufts and rings of hairs are absent from the style.

Fruit.—In all of the American species, the two-valved, strongly dehiscent legume is essentially linear and most often nearly straight, although an upward or downward curvature is exhibited by several species. One to four pods are borne at a flowering node. Those of *T. macrantha* and *T. multifolia* characteristically droop, while all others are ascending or spreading. The persistent style-base forms distally on the upper side of the legume a more or less prominent beak which effectively distinguishes the legume of *Tephrosia* from the equally tapered pods of *Galega*. Pubescence, width and length of the legume and the number of seeds are the most useful characteristics, provided fully developed pods are chosen. Pubescence is, however, sometimes deceptive. A layer of elongated, thick-walled cells arranged diagonally below the epidermis gives the ripening legume the striate appearance remarked by Rydberg (1923) and apparently is responsible for the rupture of the ripe pod and the coiling of the valves.

Seeds.—The seed-coats of all of the indigenous species are smooth and usually of various shades of brown or gray, variegated with black. Two notable exceptions are the closely-related *T. Lindheimeri* and *T. potosina*, the seeds of which are buff or stramineous and unmarked. In the introduced species, *T. noctiflora*, the seed-coat is reddish brown and strongly wrinkled. The large, flat, black seeds of another introduced species, *T. Vogelii*, bear a conspicuous white caruncle, which is seen to a lesser degree in the related species, *T. candida*. In other species the caruncle is usually inconspicuous. Characteristic variations in seed-shape from subspherical to cylindric to compressed and more or less reniform in outline occur, but crowding within the pod strongly influences both shape and size. The subglobose seeds of *T. chrysophylla*, *T. florida* and *T. spicata* contrast markedly with the cylindrical seeds of *T. tenella* and *T. cinerea* or those of *T. Vogelii*, *T. noctiflora*, *T. Lindheimeri* or *T. potosina* mentioned above. Comments on the internal morphology of the seeds of several species have been published by Martin (1946).

Measurements

All measurements included in the descriptions of species have been taken directly from dried herbarium-material, with the exception of those involving flower-parts. The data relative to flower-parts are either from specimens preserved in alcohol or from flowers expanded by boiling. Length of the dried flower as encountered in herbarium-material has been indicated in most instances, but is not significant in more than a general way, since the petals (in particular the banner) often crumple or shrink in drying.

Length of the *inflorescence* includes the peduncle between the lowermost flowering node and the next lower leaf. In most instances the length of the peduncle is noted separately as well.

Calyx-length has been measured in all instances along the upper side from the receptacle to the tips of the upper lobes. Length of the calyx-tube, where indicated, is measured between the upper and lateral lobes. The upper calyx-lobes are measured from the base of the sinus between them to the tips of the lobes. *All measurements of calyx-parts have been made from flowers at anthesis.* The relative proportions of the lobes, as well as their shape and length, change from bud to flower and from flower to fruit.

Length of the blade of the *banner* and of the claw are given separately since the banner is strongly reflexed, making measurement difficult. All measurements of *wings* and *keel-petals* include the claw, however. The keel is measured from the proximal tip of the claw to the apex of the keel.

The *staminal tube* has been measured along the lower side and does not include the full length of the stamens.

Length of the *legume* does not include the persistent base of the style which, in most instances, forms a beak on the upper side.

Relationships

Tephrosia, in the sense used in this paper, is a natural genus defined on the basis of a number of characters. These include the collar-like disc surrounding the base of the ovary, the imparipinnate leaves, the simple trichomes, the terminal penicillate stigma, the unappendaged equal anthers, the pubescent back of the banner, the wings slightly coherent with the obtuse keel, the

absence of stipels, the peculiar inflorescence and the apparently uniform occurrence of 11 pairs of chromosomes. Some of these characters are shared in various combinations with presumably related genera, but others, such as inflorescence and chromosomes, set the genus apart.

Although various relationships have been assigned to *Tephrosia* within the Tribe Galegeae, this question is badly in need of critical examination in terms of the whole plant, a project far beyond my present scope. In order to give a general idea of likely relationships, however, it may be noted that Taubert (1894) placed *Tephrosia* in the Subtribe Tephrosiinae along with *Galega* L., *Ptychosema* Benth., *Sylitra* E. Mey., *Mundulea* DC., *Millettia* Wight & Arn., *Wisteria* Nutt., *Fordia* Hemsl., *Sarcodum* Lour., *Platysepalum* Welw., *Poecilanthe* Benth., *Chadsia* Boj., *Barbieria* DC., *Peteria* A. Gray, *Poissonia* Baill. and *Bolusia* Benth.

Rydberg (1923a), considering the North American representatives of this group, divided the Tephrosiinae into two subtribes, the Craccanae, including *Galega*, *Cracca* L. (= *Tephrosia*) and *Peteria*, and the Millettianae with *Kraunhia* Raf. (= *Wisteria*). The general reliability of this bit of classification may be judged by Rydberg's statement regarding *Barbieria* which he placed in a subtribe of its own considerably removed from the Craccanae and Milletianae: "The Tephrosieae of Bentham (Tephrosiinae of Taubert) is in itself not a natural division, for *Barbiera* is not at all closely related to the rest, being distinguished by the long-clawed petals, the presence of 2 bractlets beneath the tubular calyx, and the style bearded along the upper side." This general idea may possibly be true, but the evidence presented is hardly convincing, for there are 45 endemic American species of *Tephrosia* with bearded styles and 4 of these bear bracteoles on calyx or pedicels.

Tephrosia itself has been variously divided into sections, but until much more of the Old World material can be examined it seems neither feasible nor wise to attempt to establish further formal subgeneric groups, although it is certain that a realignment will be necessary. It may, nevertheless, be worthwhile to indicate some of the possible subdivisions.

It appears to me that two principal divisions within the genus must be based on glabrous styles versus barbate styles. Although this may seem to be an arbitrary division based on a single character, it is perhaps the same type of distinction as the presence or absence of chaff or bristles on the receptacle of the Compositae which sets off large and presumably related groups of genera. Such a split in *Tephrosia* is apparently fundamental within the New World species, at least, as is borne out by related species which lead from one small group of species to another (although there are gaps). In general, the two series are composed of very different species and parallel series are not found in the two divisions, although such features as unifoliolate leaves, sympodial branching, oblique axillary inflorescences and similar flower-color may appear in otherwise quite dissimilar species.

It may also prove desirable to recognize a small, closely knit barbistyled group of species of southern Africa which includes *Tephrosia grandiflora* and its allies with large stipules and ovate, spathaceous primary bracts. Secondary bracts are completely absent. This alliance has been designated Section *Apodynomene* (E. Mey.) Harvey, Fl. Capensis **2**: 203. 1861.

There are at least two other small groups which are probably not worth recognition, but with which I am poorly acquainted. These are the sections (or genera) *Pogonostigma* and *Requienia* which include a few African species with 1-seeded fruits. The leaves of the first are compound, those of the second unifoliolate. Should these prove to be worthy of the sectional rank assigned them by Taubert, the remainder of the genus may well be designated *Eutephrosia* Harvey, Fl. Capensis **2**: 203. 1861.

The main body of the genus (*Eutephrosia,* including both barbate- and glabrous-styled species) has customarily been divided since the time of DeCandolle into the Sections *Brissonia* (Moench) DC. and *Reineria* (Neck.) DC., but these are artificial groups based upon a combination of habit (monopodial vs. sympodial) and the ratio of length of calyx-lobes to -tube, characters which are not necessarily correlated with one-another. (See Morphology: *Habit, Calyx* and *Inflorescence;* also Rydberg 1923a.) Rydberg (1923) established 17 small, completely new sections for the North American species, but some of these are

manifestly artificial and none can be rearranged or retained satisfactorily in terms of the whole genus.

Although it would be gratifying to be able to set down a chart showing the phylogeny of the American barbistyled species, the interrelationships of these plants are far from clear. Some small groups or pairs of species are clearly related to each other, and the group as a whole may be divided into two main complexes, but even after this there are a number of species apparently not very closely related to each other or to any of the small groups. The interrelationships of the latter are not very clear, either.

It must, as a result, suffice to point out that the American species fall into two principal series. The plants of the first series (A) (including Species 1 to 23) possess thin leaflets bearing stomata in the upper epidermis. The areoles between the principal parallel lateral veins are distinctly elongate. The second series (B) (Species 24 to 45) includes species with either thin or very coriaceous leaflets, generally with nearly isodiametric areoles between the lateral veins of the leaflets, and usually with few or no stomata in the upper epidermis. A strong tendency toward reduction in the number of leaflets is encountered in this series and the flowers of most of the species seem to be rose-purple.

Within Series A, two distinct subdivisions may be recognized, according to the coherence of the vexillary stamen with the staminal tube. In five closely related species of the southeastern United States, in the two species occurring in Baja California, in *Tephrosia tepicana* and in *T. madrensis* from the Sierra Madre of Sinaloa and Nayarit, Mexico, and in the more widespread *T. rhodantha*, the vexillary stamen is completely free from the staminal tube, even in the smallest buds (Species 12 to 21; see Key 2). These are all herbaceous, white-flowered species which exhibit a tendency toward reduction in leaflet-number. In the remainder of the species of Series A, the vexillary stamen is coherent with the staminal tube, although free at the base. This subdivision embraces both woody and herbaceous types. The basic flower-color appears to be white, although at least *T. virginiana* has bicolored flowers and *T. potosina* and *T. Lindheimeri*, placed here although apparently not closely connected with any of the other American species, bear rose-purple flowers. A possible connecting link between the two groups of Series A is

found in the white-flowered *T. onobrychoides* of the Gulf Coastal Plain of the United States, which approaches the southeastern species in habit and general appearance but in which the vexillary stamen is fused with the staminal tube.

Various exceptions to the general characters distinguishing the two principal groups will be noted in Table 3. Within Series A the areoles of the leaflets of *T. tepicana* and *T. madrensis* are distinctly isodiametric, although stomata are present in the upper epidermis of at least the former. The material of these two is very scanty but the vexillary stamen appears to be free, thus linking them with similar members of this group. Conversely, the areoles of *T. Pringlei* of Series B are conspicuously elongate and stomata are invariably present in the upper epidermis of the leaflets, but this plant is otherwise allied to *T. Seemannii* and *T. saxicola*. Similarly, the areoles of *T. nitens* are elongate and those of a number of other species of this group are more or less intermediate in shape, although other characters clearly link them with this assemblage.

The relationships of various pairs or small groups of species, in addition to those already mentioned, are brought out in the discussions of individual species. A branching system of relationships or a brush-heap structure would undoubtedly be far more satisfactory than the linear sequence which must necessarily be used, for I suspect that woody types of Series A with relatively many leaflets and flowers at a node, such as *T. multifolia* and *T. Sinapou*, have led to more specialized forms, such as *T. virginiana*, *T. Conzattii* and *T. leiocarpa*, and have led as well to those with a free vexillary stamen and to Series B. I have, however, tried to show in their linear arrangement such relationships as seem to be indicated by the morphological features of the plants.

Distribution and Ecology

The barbistyled Tephrosias are primarily North American in their distribution in the New World, with only *Tephrosia Sinapou* and *T. nitens* extending into South America. Outline Maps 1 to 20 indicate the distribution of individual species in North America, and this information is summarized in the accompanying Generalized Distribution Map. Such a generalized map can only indicate the total number of species known to occur in a

given region, since it is obvious that no two species will have the same range and that distributions will overlap in varying degrees. In addition, the number of species from some areas may be expected to change as our knowledge of Mexico and Central America increases and new species are discovered. Nevertheless, it will be seen immediately that the chief diversity of the barbistyled group is in the mountains of southwestern Mexico,[1] particularly in the region from southern Sinaloa to Guerrero and Morelos (areas in solid black on the map). Twenty-seven of the 45 species are known to occur in this territory and 20 of these are endemic to this area.

Within this region of concentration of species, two divisions apparently exist: a northern part consisting of southern Sinaloa, Nayarit and western Jalisco separated by Michoacán from a southern area including Guerrero, southern México[1] and Morelos. This southern region is in turn subdivided by the lowlands of the Río Balsas into a northern portion (southern México, Morelos and northern Guerrero) and a southern portion (the remainder of Guerrero south of the Río Balsas). Eleven barbistyled species of *Tephrosia* are known from each of these areas and a total of 17 from the two together. The decrease in concentration represented by Michoacán with only 6 species may be more apparent than real since much of the western part of the state which may be expected to harbor Tephrosias is as yet largely unknown botanically and otherwise.

Outside this rich band of mountainous country with 27 species the number of species declines rapidly, although some endemism is still evident, for only a few types are really widespread, extending from various parts of Mexico varying distances into Central or South America. These widespread species include *Tephrosia nicaraguensis*, *T. multifolia*, *T. nitens*, *T. Sinapou* and *T. rhodantha*.

Of the eight species known from Oaxaca, only one (*T. Pringlei*) is confined entirely to that state. The others are shared to the north, west or east. One type of distribution also seen in other genera is exemplified by *T. Conzattii*, represented from Oaxaca, Guerrero and southern México, and another in *T. Langlassei*,

[1] In order to distinguish between the Republic of México and the State of México, the English spelling is used throughout for the republic and the accented Mexican form for the state.

GENERALIZED DISTRIBUTION OF THE INDIGENOUS
BARBISTYLED TEPHROSIAS OF NORTH AMERICA
FIGURES INDICATE THE
NUMBER OF SPECIES
KNOWN FROM A REGION
1-3 SPECIES
4-6 SPECIES
7-9 SPECIES
10 OR MORE SPECIES

which extends both north and west and then southward into Chiapas. Still another distribution is that of *T. belizensis*, reaching from Veracruz across the northern side of Oaxaca into Chiapas and British Honduras. In Veracruz, *T. lanata*, in addition to *T. belizensis* and *T. Langlassei*, extends along the slopes of the eastern sierra southward and eastward; the other three species occurring in Veracruz are widespread.

Guatemala can claim at present only one endemic species, and that an undescribed, distinct but sterile plant collected by Steyermark in the Department of Huehuetanango (see Species 21). The other six species (the undescribed plant was omitted from the generalized map) include five widely distributed types and *T. lanata*. Southward from Guatemala the number of species decreases and only *T. multifolia* and *T. nitens* are known to reach Panama. It is strange that *T. Sinapou* has not been collected beyond El Salvador, for it has a wide distribution in South America and appears in the West Indies.

No collections of *Tephrosia* are known to me from Hidalgo, Puebla, Aguascalientes, the higher parts of México, and most of eastern and northern Jalisco and Michoacán, although two species reach the northern side of this area in the oak forests of Guanajuato and Querétaro, and one extends northward again to a corner of Tamaulipas.

Eleven barbistyled Tephrosias occur in the United States. *Tephrosia leiocarpa* and *T. Thurberi* reach the mountains of southern Arizona and *T. potosina* extends from San Luis Potosí into Texas, where its range meets that of the related *T. Lindheimeri*. This last species has not yet been collected in Mexico but is not uncommon in southern Texas to the Mexican border at the Río Grande.

The most widely distributed species in the United States is *Tephrosia virginiana*, which is found from New Hampshire to Wisconsin and south to Florida and western Texas. *Tephrosia onobrychoides* occupies a part of the Mississippi embayment of the Gulf Coastal Plain. The remaining five species, all plants with the vexillary stamen free, radiate more or less concentrically northward from central peninsular Florida, with *T. Rugelii* occupying the smallest and *T. spicata* the largest area, the latter extending well off the Coastal Plain. Plants presumably most

closely related to these five species occur in Baja California, western and southern Mexico, and Guatemala.

Each of these present-day distributional patterns is, of course, delimited by the area covered by the particular set of environmental conditions to which that species is attuned. Each distribution must also reflect to some degree both the history of the species and geological history. Presumably, most of these species already occupy the suitable habitats now available to them and are prevented by unfavorable environmental conditions from expanding their ranges farther. An attempt to explain distributions with only the present data from which to judge would be both premature and unwarranted, but a number of coincidences are strikingly suggestive and worth underscoring.

Although ecological notes concerning many species of Mexico and Central America are scanty or lacking altogether, it is evident that the majority of the Mexican species are confined to well-drained soils in open oak and/or pine forests in non-calcareous areas mostly below 2300 m. (ca. 7500 feet). Exceptions are found in relatively wide-ranging species such as *T. multifolia*, *T. rhodantha* and *T. nitens*, which may occur outside the oak-pine forests in open areas at low altitudes, and in *T. leucantha* of oak and pine forests southward from northwestern Chihuahua to Guanajuato and Querétaro, where it may be found at 2500 m. (8000 feet). It may be significant that the greatest diversity of the barbistyled group is in mountainous regions in which rain is lacking during winter and spring and the winters themselves are warm.

Part of the absence of the genus from Hidalgo, Puebla, Aguascalientes, eastern and northern Jalisco and Michoacán and the higher parts of México (assuming that this absence is real and not due to insufficient collecting) may be attributed to semi-desert conditions which occupy a portion of this expanse. In Hidalgo, where extensive search has failed to reveal a single species of *Tephrosia*, it is perhaps significant that oak and pine forests where Tephrosias might be expected to occur are primarily on soils of calcareous derivation, whereas apparently non-calcareous soils are the rule in those parts of Mexico where numerous species have been collected.

In the United States *Tephrosia virginiana*, *T. onobrychoides* and the five species of the southeastern states are always found in open habitats in non-calcareous soils. All of the stations of *T. onobrychoides* appear to occur on well-drained, leached, sandy, acid, non-calcareous red and yellow podzolic soils of the Norfolk-Ruston, Caddo-Beauregard, Hockley-Katy, Lake Charles-Crawley and Hanceville-Conway series and the species disappears abruptly when the black prairie and other Rendzina soils of the Houston-Austin-Denton and Victoria-Goliad series (derived from marls, chalks and calcareous clays) (U. S. Dept. Agr. 1938) are reached. This coincidence suggests that at the western edge of the range edaphic factors may be limiting, but that other factors at various other points on the periphery of the species may also be limiting, for suitable Norfolk-Ruston soils are widely distributed around the Coastal Plain to Virginia.

Tephrosia Rugelii, *T. chrysophylla*, *T. florida*, *T. hispidula* and *T. spicata*, of the southeastern United States, all occur on sandy soils of the Coastal Plain; the first four are completely restricted to that area, but *T. spicata* extends into well-drained sandy and sand-clay soils over a wider area. *Tephrosia Rugelii* occupies the smallest expanse, being found on sands of the Leon-Bladen and Norfolk-Blanton soils primarily in oak barrens in the flatwoods regions of central peninsular Florida. *Tephrosia chrysophylla* grows prostrate on open white sand in dry oak barrens over a larger range, while *T. florida* occupies a still larger area, always on sandy, but often somewhat more shaded and moister soils. An extreme is reached in *T. hispidula* which is distributed primarily in the grassy and sedgy pine flatwoods along the Atlantic Coastal Plain in sandy soils of the Leon-Bladen and Coxville-Portsmouth-Bladen groups, which may be moist or even wet, in contrast to all the other species with which I am acquainted.

With all of these species the circumstantial evidence strongly suggests that edaphic factors are important in determining distribution. *Tephrosia florida* is, for example, very abundant on the Norfolk sand in Richmond County, North Carolina, in the northern part of its range, but disappears along with the long-leaf pine (*Pinus australis* Michx. f.) as the abrupt transition to the heavier Georgeville-Alamance soils occurs. As was indicated previously, almost all of the barbistyled species are known on

soils of non-calcareous derivation, although some of the glabrous-styled species (as **T. cinerea*) may grow directly on limestone outcrops. The only exceptions of which I am aware are *T. potosina* and *T. Lindheimeri* which, to judge from notes on various herbarium-specimens, may sometimes occur on calcareous soils.

It seems likely, too, that the isolating mechanisms between some of the species of *Tephrosia* are at least partially ecological. As was noted above, *Tephrosia chrysophylla* usually occurs in drier and more open habitats than those occupied by *T. florida*. Occasionally, however, the two species occur together and I have found intermediate plants, presumably hybrids (see Species 19a) only in such localities. Similarly, intermediates (inconclusively hybrids) were found along a road-bank where *T. spicata* grew at the edge of brush and *T. chrysophylla* on the exposed white sand. Another suggestive but inconclusive example was seen in Emanuel County, Georgia. Here *Tephrosia florida* was abundant in open ground between trees of *Quercus incana* Bartr. and *Q. alba* L., while *Tephrosia hispidula* grew in moister, sedgy ground with pines. In a narrow zone of gradation between these habitats plants morphologically intermediate between these two distinct species occurred. Except at this locality, I have never found *T. florida* and *T. hispidula* in contact with one another.

(*To be continued*)

The White Form of Aster puniceus, var. firmus.—In Rhodora **51**: 95. 1949, Prof. Fernald implies that *Aster puniceus* L., forma *albiflorus* R. Hoffm. is the correct name for the albino of *A. puniceus*, var. *firmus* (Nees) T. & G. Unfortunately, however, this name is illegitimate according to Article 30 of the International Rules, which states that two subdivisions of the same species, even if they are of different rank, cannot bear the same subdivisional epithet, unless they are based on the same type.

A. puniceus, var. *lucidulus* Gray, forma *albiflorus* R. Hoffm. in Proc. Bost. Soc. Nat. Hist. **36**: 339. 1922 is antedated by the same epithet, based on a different type, published as *A. puniceus*, var. *albiflorus* Farwell in Rep. Mich. Acad. Sci. **17**: 171. 1916. This proves to be, as shown by Prof. Fernald, the albino form of typical *A. puniceus* L. He also shows that *A. puniceus*, f. *albi-*

florus (Farwell) Shinners in Am. Midl. Nat. **26:** 414. 1941 is made illegitimate by the prior publication of f. *albiflorus* R. Hoffm. Accordingly, he describes the new form, *A. puniceus* L., forma *candidus* Fernald l. c., of which the two ternary combinations based on Farwell's type become facultative synonyms.

This curious application of the rules, whereby three names, based on two different types, cancel each other out and are made unavailable, makes it necessary to create a name for the albino of *A. puniceus*, var. *firmus* (Nees) T. & G.

ASTER PUNICEUS L., var. FIRMUS (Nees) T. & G., forma **etiamalbus,** nom. nov. *A. puniceus*, var. *lucidulus*, f. *albiflorus* R. Hoffm. in Proc. Bost. Soc. Nat. Hist. **36:** 339. 1922, non *A. puniceus*, var. *albiflorus* Farwell in Rep. Mich. Acad. Sci. **17:** 171. 1916. —HASKELL VENARD, Atlanta, Georgia.

BASICLADIA IN MAINE.—In November, 1948, a common musk-turtle, *Sternotherus odoratus* (Latreille), was captured in Pushaw Stream in Old Town, Penobscot Co., Maine. This turtle bore a growth of alga on the marginal plates of the carapace and on the dorsal surface of the beak. The alga was identified by Dr. E. C. Ogden of the University of Maine as *Basicladia chelonum* (Collins) Hoffmann and Tilden. The turtle has been turned over to Dr. A. H. Gustafson of Bowdoin College for further study, in the hope that fruiting bodies of the alga may be found, as the literature indicates that such structures are as yet undescribed.

An examination of the literature indicates no previous record of this genus from Maine. In fact, no record was found from any New England state other than Massachusetts. Smith[1] cites *Basicladia* from Massachusetts, Michigan, Minnesota, and Iowa. It does not seem reasonable that these scattered reports are indicative of true distribution and frequency of the alga. *Basicladia* has been found only on turtles, both those which spend almost all their life in the water, such as the musk-turtle, and those which have the "sunning" habit, as do the painted turtles. It is likely that an examination of more turtles will bring to light many new records for this alga.—R. M. CHUTE, Stillwater, Maine.

[1] SMITH, G. M., The Fresh-water Algae of the United States, p. 432 (1933).

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